Astronomy Definitions

Ref: *Sefer Zemanim, Hilchot Kidush Hachodesh*

ASTRONOMY DEFINITIONS

(As per *Kidush Hachodesh*)

TIME

Day = 12 hours

Night = 12 hours

1 hour = 1080 units (chosen because it can be divided by 2, 4, 8, 3, 5, 6, 9 and 10)

1 unit = 76 moments

1 lunar month = 29 days, 12 hours, 793 units (Time between one *molad* – conjunction and next) **– (29d 12h 793u)**

1 lunar year = 354 days, 8 hours, 876 units (354d 8h 876u)

1 leap year = 383 days, 21 hours, 589 units (383d 21h 589u)

1 solar year = 365 days and 6 hours (365d 6h)

1 Solar year = 365d 5h 997u 48m (another opinion)

Difference between a lunar and solar year is 10d 21h 204u (10 days, 21 hours and 204 units) – lunar shorter than solar

According to 7-day groups Remainder for lunar month = 1d 12h 793u

Remainder for lunar year = 4d 8h 876u

Remainder for leap year = 5d 21h 589u

Seven-day groupings allow us to determine which day of the week that the next month, year or leap year will occur.

***We begin calculation* 2d 5h 204u (First Year of Creation) – night of 2nd day of week at 5 hours and 204 units**

19-year cycle = 7 leap years + 12 ordinary years = *machzor* (It takes approximately **19** years for the total of lunar years to equalise with the solar years)

Difference between solar calendar, and lunar (in 19-year cycle) is 1 hour and 485 units (0d 1h 485u) – lunar less than solar

In 19-year cycle, leap years occur at years 3, 6, 8, 11, 14, 17, 19

Remainder of 19 years' cycle = 2d 16h 595u (according to 7-day groups)

SEASONS

*According to the opinion that a solar year is **365¼ days.*** **(365d – 6h)**

Solar year = 365¼ days.

91 days, 7½ hours between each season. (From a time aspect, each season starts 7½ hours later than the previous season)

Spring equinox (Vernal) of first year of Creation took place 7d 9h 642u before the *molad* of the month of *Nissan*.

In 19-year cycle, lunar time is shorter than solar time by 0d 1h 485u

Every *28 years* equinox falls at exact same day of week and same time as the original. (Difference of 1

equinox from 1 year to next is 1 day, 6 hours. Therefore after 28 years this equals 35 days = 7 full weeks so every 28 years equinox occurs on same ay week and at same time)

There are 30 hours between 1 equinox (or solstice) and the next. i.e. every year the season will start 6 hours later than the previous.

According to the opinion that solar year is 365d 5h 997u 48m i.e. slightly less than 365¼ days

Calculation are same as perek ט׳ and is the one favoured by the Sages of Israel.

According to this calculation the difference between a solar and lunar year = **10d 21h 121u 48m** and difference between each 19-year cycle = **0**.

When you know the start of any one season, rest can be calculated as in perek ט׳. **91d 7h 519u 31m between each season.**

First Vernal Equinox of Creation = 9h – 642u (9 hours, 642 units) =Tuesday at 6pm

Of the two calculations, this one is the more accurate.

However, both are approximations based on the mean rate of progress of the sun.

When one considers the actual position of the sun at these times, the vernal equinox will take place approximately two days earlier.

CONSTELLATIONS

Fundamental Principle

Heavenly Sphere divided into **360°** (degrees)

There are 12 Constellations

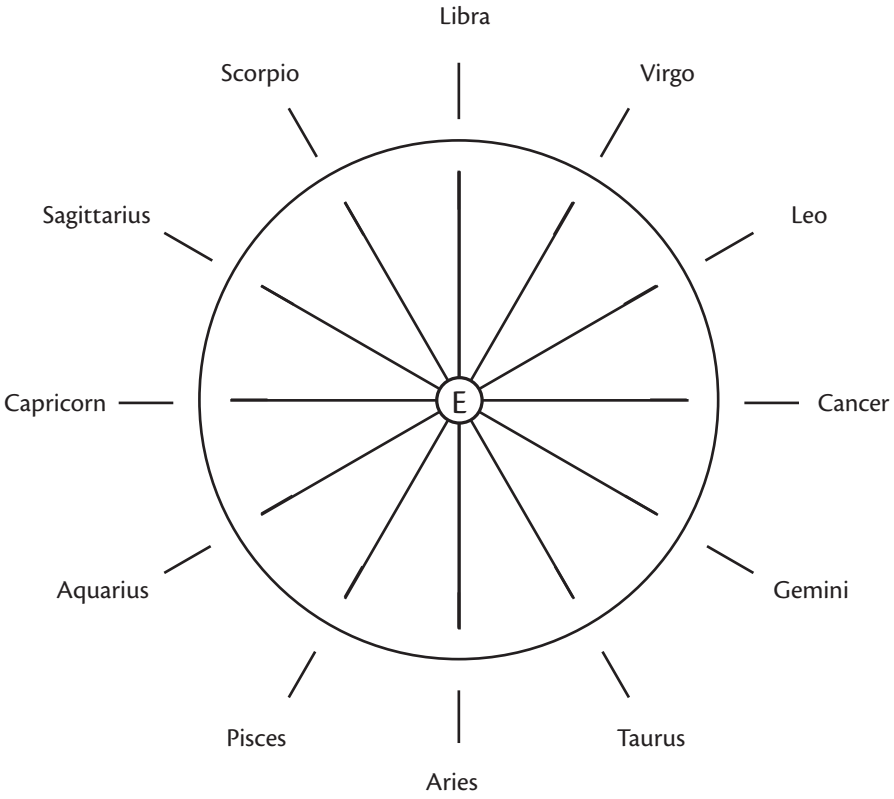
Therefore, each Constellation = **30°**

1° = 60′ (minutes)

1′ = 60″ (seconds)

1″ = 60‴ (thirds)

Etc.



For reference, the start of the Zodiac is Aries.

The Earth (E) is at the centre of the Zodiac, but not at the centre of sun orbit (nor other planets).

Tleh (Aries) **– 0–30°**

Shor (Taurus) **– 30–60°**

Teomim (Gemini) **– 60–90°**

Sartan (Cancer) **– 90–120°**

Aryeh (Leo) **– 120–150°**

Betulah (Virgo) **–150–180°**

Moznaim (Libra) **– 180–210°**

Akrav (Scorpio) **– 210–240°**

Keshet (Sagittarius) **– 240–270°**

Gdi (Capricorn) **– 270–300°**

Deli (Aquarius) **–300–330°**

Dagim (Pisces) **– 330–360°**

When subtracting many degrees from smaller number one must add **360°** to the smaller number

e.g. **100° – 200° = 460° – 200° = 260°**

Distance travelled by:

Sun – **59′ 8″ in 24 hours**

28′ 35′ 1″ in one month

Gavoha (apogee) – point of suns orbit furthest from earth – **± 1° in 70 years**

Moon around earth **13° 10′ 35″ in one day** (as seen from earth)

Epicycle of moon – its own movement – **13° 3′ 54″ in one day** (as seen from earth)

Head & tail of moon (Point where orbits of moon and sun meet) – **3′ 11″ per day**

Some Further Definitions

LATITUDE OF MOON

This is the moons inclination to the suns orbit. Never exceeds **5°**. The greater the inclination, the larger will be the visible crescent of moon. The orbit of moon intersects the orbit of the sun at an angle after intersecting the moon either to the north or south of suns orbit.

A northerly latitude (head orbit) caused moon to set later. A southerly latitude (tail of orbit) causes moon to set earlier.

At the points of intersection, the moon is not inclined at all.

The head moves from east to west, apposite to the direction of the sphere of the constellation at a uniform speed. Due to this there are several stages needed to calculate the longitude of the moon.

LONGITUDE

At time of conjunction (*molad*), sun and moon are at same longitudinal point. Also at time of full moon. Thereafter the distance in longitude between the sun and the moon determines how much moon is seen (the greater the distance i.e. longitude; the greater is the visible crescent)

This difference in latitude between sun and moon explains why there is not an eclipse at every new and full moon.

An eclipse will only occur when conjunction (or full moon) takes place at the point of intersection of these two orbits.

THE COURSE OF THE LATITUDE

This is the distance travelled by moon from the head to its current position.

SECOND LONGITUDE

For longitude adjustments, minutes are always subtracted. This adjustment is needed because it the evening the moon will always appear closer to the horizon than it actually is.

SECOND LATITUDE

Latitude adjustments could be added or subtracted. If moons latitude is northerly we subtract minutes. If southerly, we add minutes to first latitude.

The first and second latitude readings let us know if the moon crescent will be large enough to be visible.

THIRD AND FOURTH LONGITUDE

These readings allow us to see if there is enough time to see the moon before it sets.

It is also a process of translating the position in *Yerushalayim* to a position on the equator.