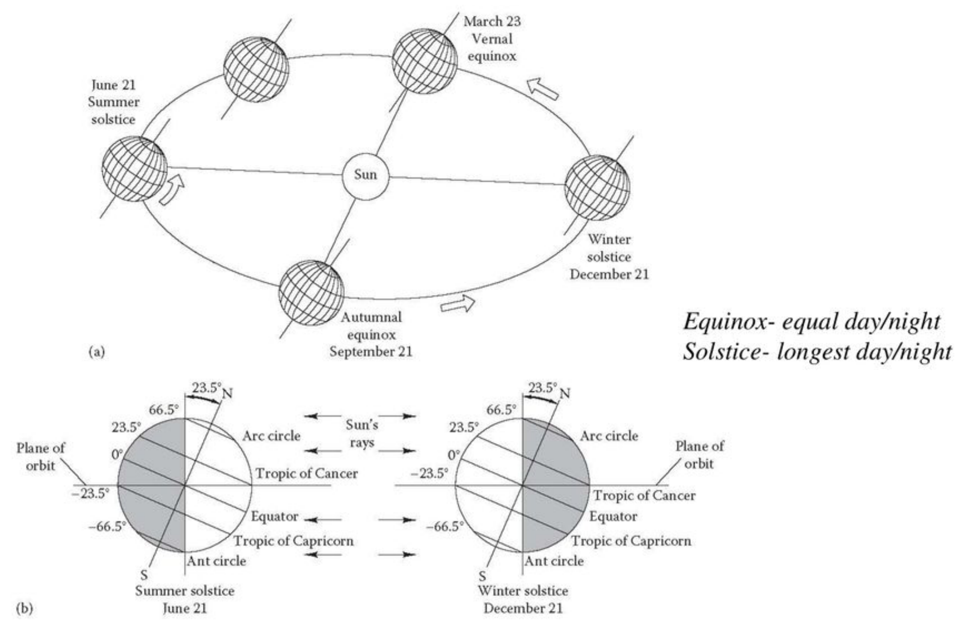


Figure 4.1.Geometry of the earth's orbit and inclination of polar axis: (a) entire orbit and (b) enlarged detail, solstices.

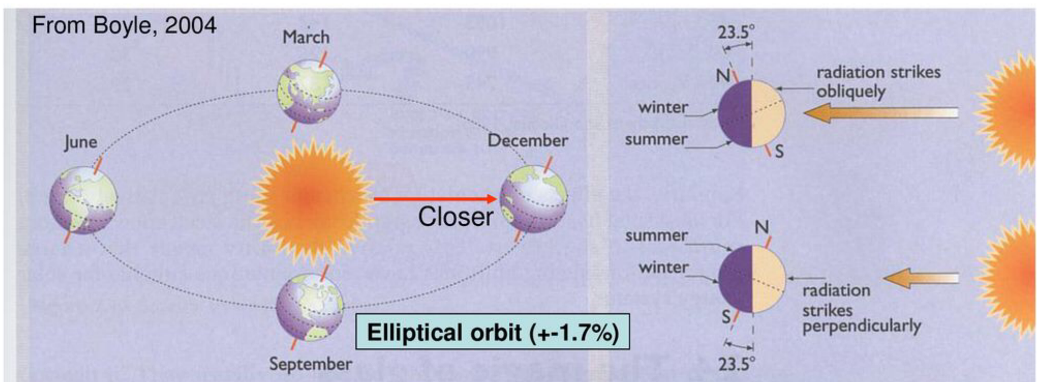
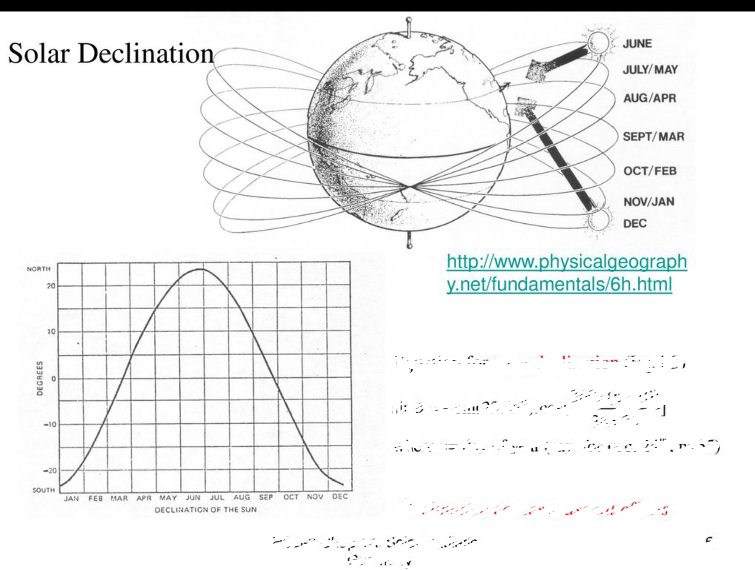


Figure 2.9 The earth revolves around the sun with its axis tilted at an angle of 23.5°

Figure 2.10 The tilt of the earth's axis creates summer and winter



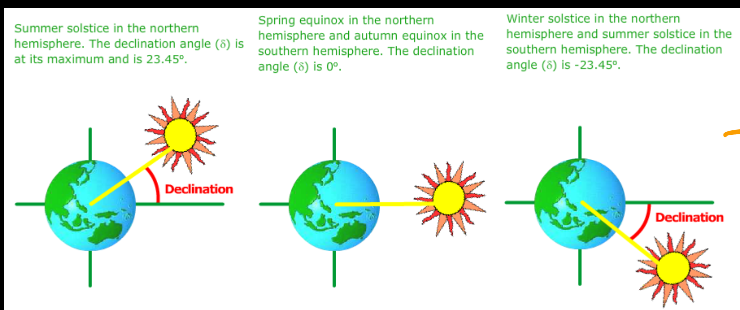
TERRESTRIAL SOLAR RADIATION

Solar Radiation on Earth Surface is relatively constant, but slightly varies due to

- atmospheric effect, including absorption and scattering
- local variation of atmosphere
- latitude of the location.
- the season of the year and time of the day.

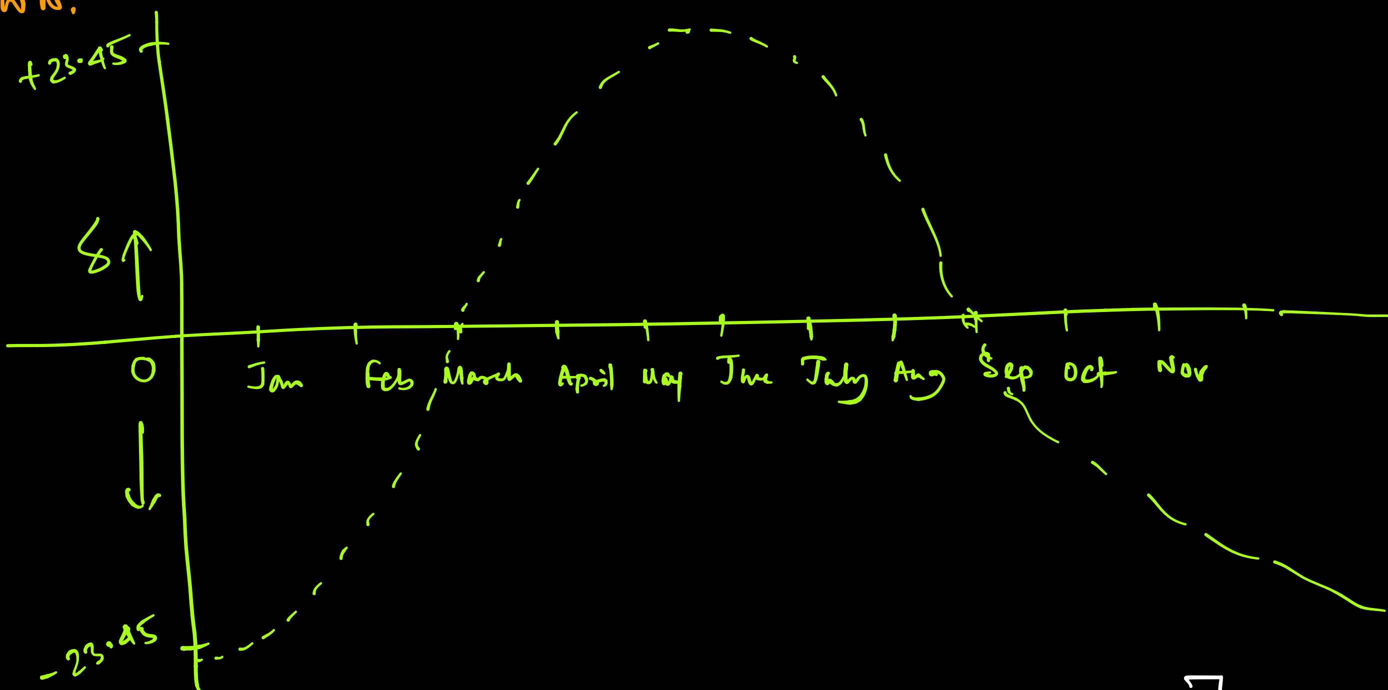
DECLINATION ANGLE

THE DECLINATION ANGLE, DENOTES 'δ' VARIES SEASONALLY DUE TO THE TILT OF THE EARTH ON ITS AXIS OF ROTATION AND THE ROTATION OF EARTH ARROUND SUN. IF THE EARTH WAS NOT TILTED ON ITS AXIS, THEN $\delta = 0$. ALWAYS. HOWEVER THE EARTH IS TILTED, by $23 \cdot 45°$ AND THE DECLINATION ANGLE VARIES +/- $23 \cdot 45°$. ONLY AT THE SRRING AND FALL EQUINOXES, δ is zero.



THE DECLINATION OF THE SUN IS THE ANGLE BETWEEN THE EQUATOR AND A LINE DRAWN FROM THE CENTRE OF THE EARTH TO THE CENRE OF THE SUN.

* THE SEASONAL VARIATION OF DECLINATION ANGLE IS SHOWN.



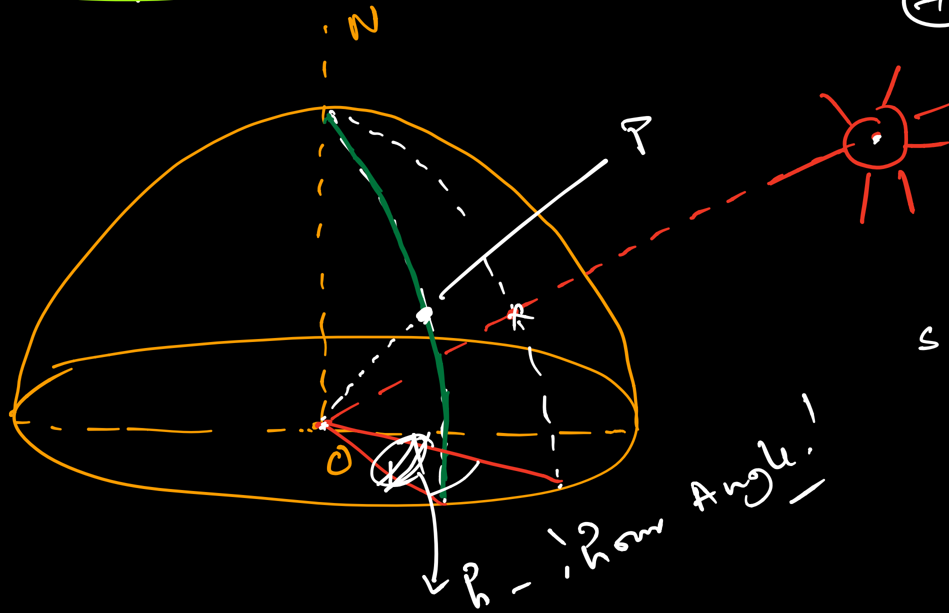
$$\boxed{\delta} = 23 \cdot 45 \sin\left[\frac{360}{365}(284+n)\right] \quad (1)$$

n is the day of the year.
[eg. Jan 1st; n = 1]

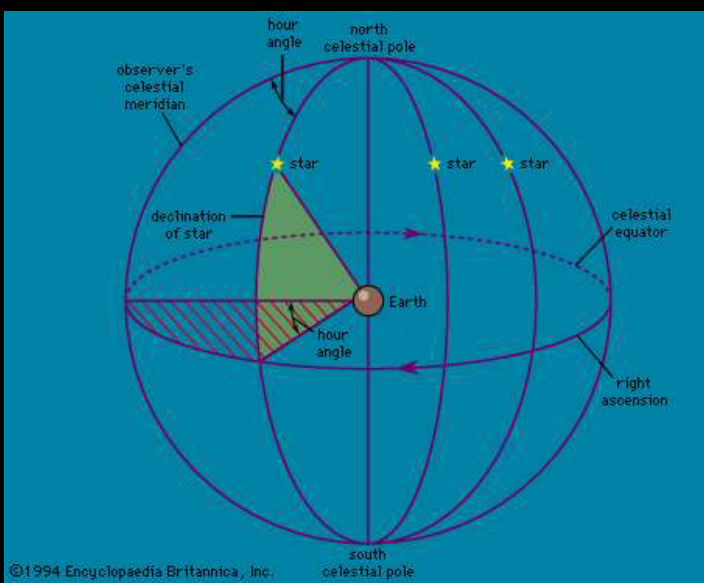
(*) THE EQUATION ALSO ASSUME THAT, THE SUN'S ORBIT IS A PERFECT CIRCLE AND THE FACTOR OF 360/365 CONVERTS THE DAY NOs

(TO A POSITION IN THE ORBIT.

HOUR ANGLE (h)



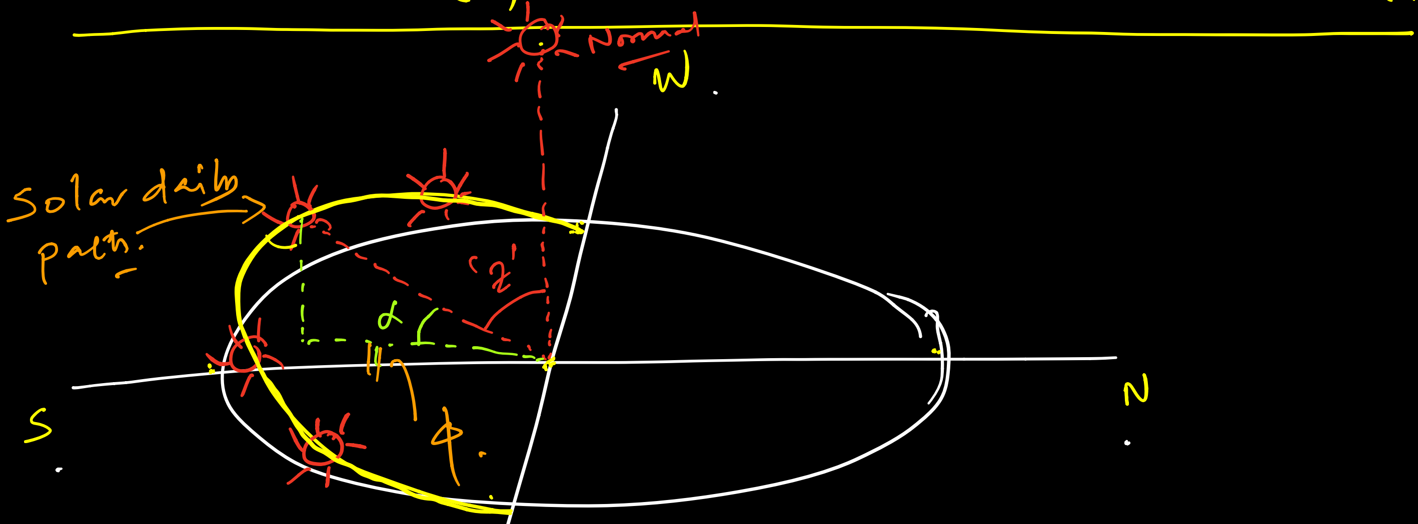
(*) THE ANGLE MEASURED ON THE EARTH'S EQUITORIAL PLANE BETWEEN THE PROJECTION OF OP AND THE PROJECTION OF THE SUN-EARTH CENTRE LINE.

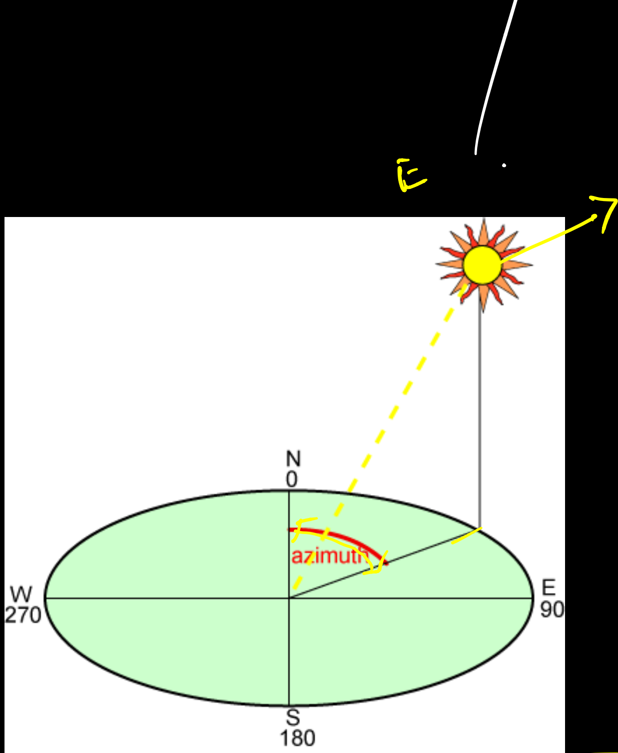


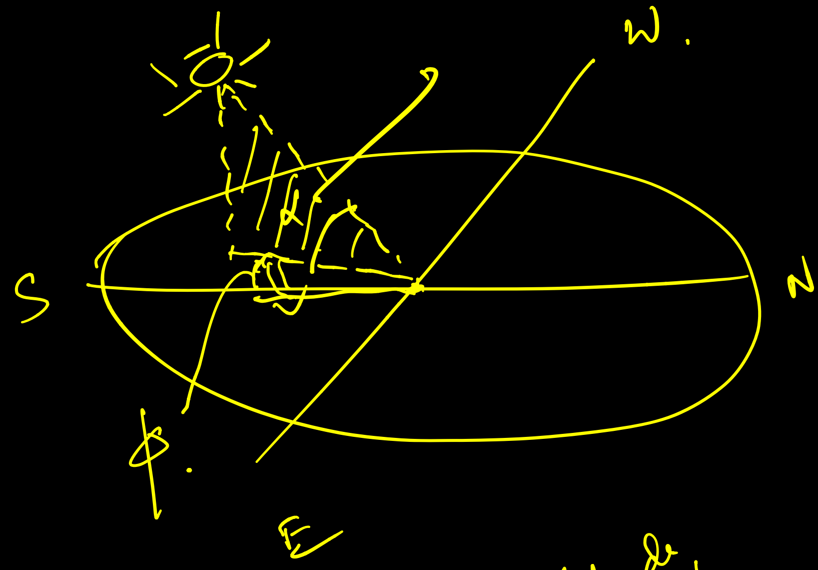
(*) ACCORDING TO BRITANNICA.

HOUR ANGLE, IN ASTRONOMY, THE ANGLE BETWEEN AN OBSERVER'S MERIDIAN (A GREAT CIRCLE PASSING OVER HIS HEAD AND THROUGH THE CELESTIAL POLES) ON WHICH SOME CELESTIAL BODY LIES.

ZENITH ANGLE, (z) ALTITUDE ANGLE (α) and AZIMUTH ANGLE (φ)



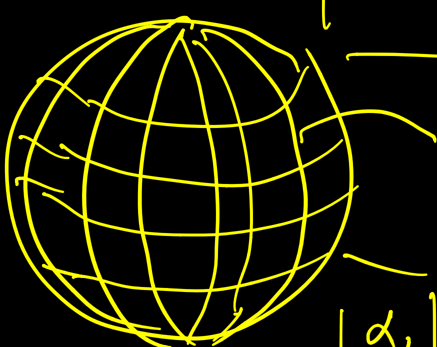




latitude angle.

$$\cos z = \sin \alpha = \sin L \sin \delta + \cos L \cos \delta \cos h. \quad (2)$$

$$\sin \phi = \cos \delta \frac{\sin h}{\cos \alpha} \quad (3)$$



Sun rise and Sun Set.

Sun set. , h_s

hour angle at Sun set. $= h_s$

$\alpha,$
$z,$
ϕ

at Sun Set condition,

$\alpha = 0$

$$\sin \alpha = \sin 0 = \sin L \sin \delta + \cos L \cos \delta \cos h_s$$

$$0 = \sin L \sin \delta + \cos L \cos \delta \cos h_s.$$

$$\cos h_s = -\tan L \tan \delta$$

$$h_s = \cos^{-1}[-\tan L \tan \delta]$$

$$h_s = \frac{1}{15} \cos^{-1}[-\tan L \tan \delta] = 2h.$$

PROBLEM → FIND THE SOLAR ALTITUDE (α) AND AZIMUTH ANGLE AT 2 hrs. AFTER LOCAL SOLAR NOON, ON JUNE 1st. FOR A CITY LOCATED AT 40°N. LATITUDE. ALSO FIND THE SUNRISE AND SUNSET TIME AND THE DAY LENGTH.

$h = +30°$, $n = 152$

$L = 40° N.$

α, ϕ

Total day length $= \frac{2}{15} \cos^{-1}[-\tan\delta \tan L]$

$$\delta = 23.45 \sin\left[\frac{360}{365}(284 + 152)\right]$$

$$= +22°$$

Total day length. $= \frac{2}{15} \cos^{-1}[-\tan L \tan\delta]$

$$= \frac{2}{15} \cos^{-1}[-\tan 40 \times \tan 22°]$$

$\boxed{\sin\phi = \cos\delta \frac{\sin h}{\cos\alpha}}$

$\boxed{\alpha = 58.9°}$

$\boxed{\phi = 63.9°}$

$\boxed{\text{day length} = 14.6 \text{ hr.}}$

7.3h.

What time of Sunset / Sunrise.

12.00 noon. + 7.3

7.3h   7.3h

noon

Sunrise.   Sunset

4.40 am.   12 –   7.20 pm

12 – 7.3

$\frac{360°}{24} = 15°$