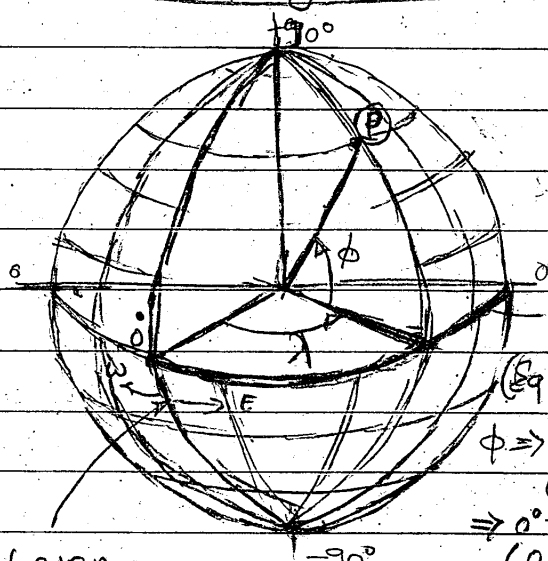
16-Sep-2025 Term 3 / Week 9

Latitude & Longitude Review



φ ⇒ 0° to 90°N (0 to +90°)
⇒ 0° to 90°S (0 to -90°)

Reference Longitude or Meridian (Greenwich 0°)

λ ⇒ 0 to 180° E (0 to +180°)
⇒ 0 to 180° W (0 to -180°)

- Latitude and longitude values specify any point on spherical earth.
- for example, at point 'P'

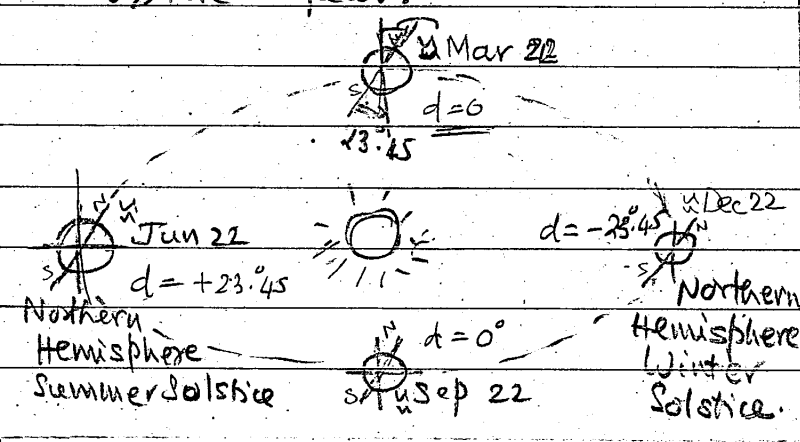
Latitude (φ) = +65° (say) (65° N)

Longitude (λ) = +85° (say) (85° E)

- On the Northern hemisphere the latitude can be determined by elevation angle of the pole star to the horizon.
- However, a more versatile method is to measure the

elevation angle of the Sun at mid day or Solar noon.

- Solar elevation angle can be established by measuring the shadow of a vertical pole!
- However, to determine the latitude we need to know "declination of earth" relative to the Sun (d) This depends on the day of the year.



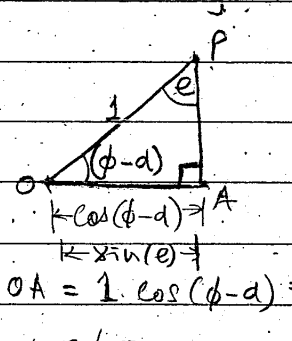
- Earth's declination Angle (d)

$$d = 23.45 \sin\left(360° \times \frac{(284 + N)}{365.25}\right)$$

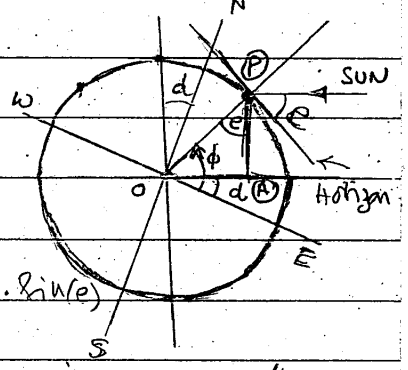
where N = 1 for Jan 1
∴ N = 365 for Dec 31

- Latitude Using Sun's Elevation (e)

Considering △ OAP & Radius = 1



OA = 1 cos(φ-d) = 1. sin(e)



we have:

sin(e) = cos(φ-d) ⇒ Northern Hemisphere

sin(e) = cos(d-φ) ⇒ Southern Hemisphere

Longitude

- Determination of longitude is quite simple.
- One rotation of earth corresponds to 360° movement of longitude, which is also 24 hrs.

$\therefore$ 24 hrs $\Rightarrow$ 360°

$\therefore$ 1 hr $= \frac{360°}{24} = 15°$

Also, 15° $\Rightarrow$ 1 hr or 60 min

$\therefore$ 1° longitude $\Rightarrow \frac{60}{15} = 4$ min

- Hence, clock set to Reference Meridian (GMT or UTC) can be used to determine longitude.

Ex.2 The clock set to GMT shows 4:17 AM at mid-day of a given location. What is the longitude of the place.

The location is (12 Noon − 4:17 AM) ahead of GMT, ie, 7 hrs 43 min

we have:

7 hrs $\Rightarrow 7 \times 15° = 105°$

43 min $\Rightarrow \frac{43}{60} \times 15 = 10.75°$

$\therefore$ The latitude $= 105° + 10.75° = +115.75°$ (E)

Ex.3 (Home work)

A sailor has reached land on 8th Jun, sailing West of England.

At local Noon — ship's clock shows 5:06 PM (GMT)

Sun's Elevation (e) = 75.6°

Ex 1

The sun's elevation angle (e) measured at Glenbrook at mid-day on 17th Aug 2025 is given to be 43.0145°. Calculate the latitude of Glenbrook.

For 17 Aug 2025, N = 229

$\therefore$ Earth's declination angle:

$$d = 23.45 \sin\left(360° \times \frac{(284+229)}{365.25}\right)$$

$$= 13.2396°.$$

We have: for Southern Hemisphere

$\sin(e) = \cos(d - \phi)$

ie, $\sin(43.0145°) = \cos(13.2396° - \phi)$

$\therefore \phi = -33.7458°$

What is the latitude & longitude and where he has landed?

Longitude (λ)

At local Noon, clock shows 5:06 PM (GMT)

$\therefore$ It is behind by $5 \times 60 + 6 = 306$ min

$\therefore$ Longitude $= \frac{-306}{4} = -76.5°$ (West)

Note: $15°/hr \; (\lambda) \Rightarrow 4$ min / deg longitude.

Latitude (ϕ)

8th Jun $\Rightarrow$ N = 159

(31 + 28 + 31 + 30 + 31 + 8)

$\therefore$ Declension (d) $= 23.45 \sin\left(\frac{360 \times (284+159)}{365.25}\right)$

$= 22.8147°$

We have $\sin(e) = \cos(\phi - d)$

ie, $\sin(75.6°) = \cos(\phi - 22.8147°)$

$\therefore \phi - 22.8147° = \cos^{-1}(\sin(75.6°))$

$= 14.4°$

$\therefore \phi = 37.2147°$

The sailor is in Yorktown, Virginia, USA