Tides in the Ocean

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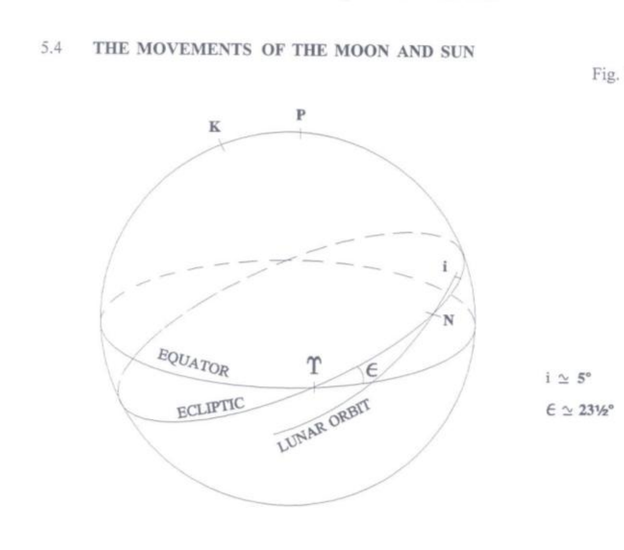
Synodic month

- Since the Earth is constantly moving along its orbit about the Sun, the Moon must travel slightly more than 360° to get from one new moon to the next. Thus, the **synodic month**, or lunar **month**, is longer than the **sidereal (w.r.t. stars) month**. A **sidereal month** lasts 27.322 days, while a **synodic month** lasts 29.531 days

Ecliptic

The **ecliptic** is the apparent path of the Sun on the celestial sphere

The moon's orbit is inclined at an angle of ~ 5 degree to the ecliptic



On March 21, when the sun crosses the equator, the intersection of the orbital plane of the earth takes at the 'First Point of Aries' (♈).

Moon's orbit

- The time taken by the sun for completing one 'apparent' orbit w.r.t. to the First Point of Aries is 365.24 days (tropical year) ω_3 0.0411 deg/hr (mean solar hour)

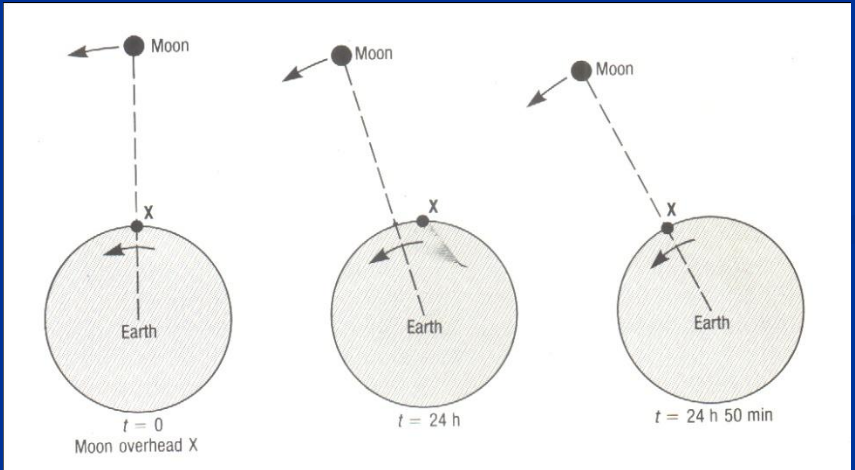
- The moon completes one revolution w.r.t. the First Point of Aries in 27.32 days (tropical month- declination) ω_2 0.549 deg/hr
- For an observer on the earth, the moon's phase repeats in 29.53 days (synodic month- spring-

Long-period changes

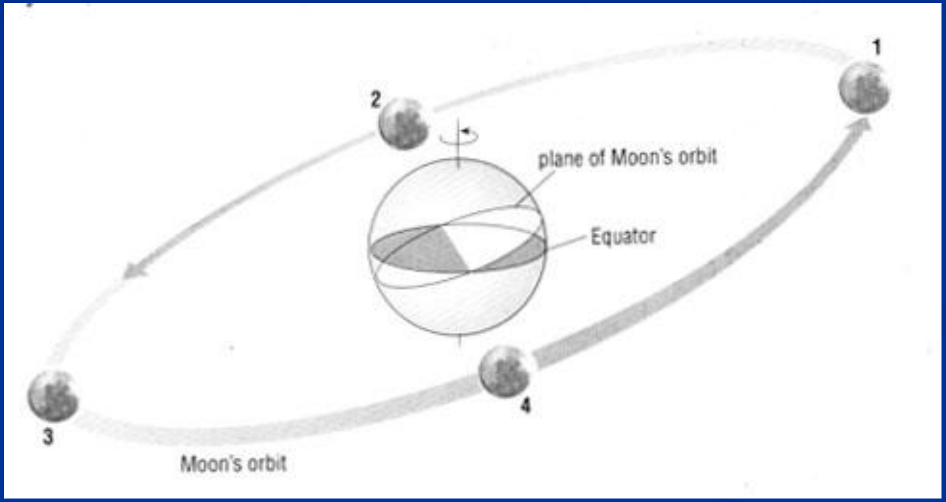
- Advance of lunar perigee (west to east) in about 8.85 years ω_4 0.0046 deg/hour
- Regression of the nodes- the plane in which the Moon orbits the Earth is inclined at 5^0 9’ . This plane rotates over a period of 18.61 years (nodes are the points where the moon’s orbit intersects the ecliptic. The nodes rotate from east to west, completing one revolution in 18.61 years. Accordingly, Lunar declinations also varies) ω_5 0.0022 deg/hour

Occurrence of high tide and the passage of moon's transit

- Every day the occurrence of high tide at a given place occurs by 50 minutes (on an average) later than the previous day

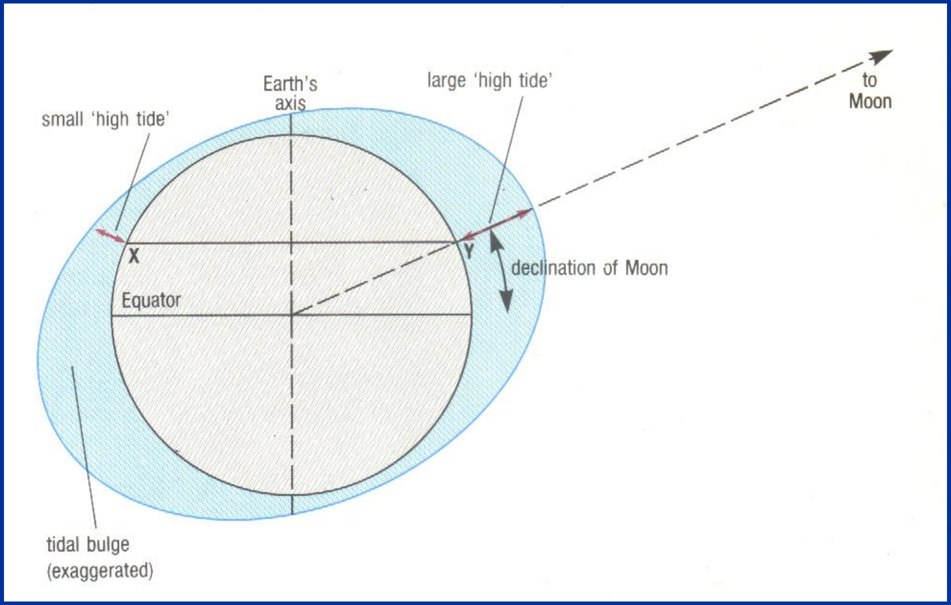


Declination of the moon



(Courtesy: Tides, Waves and shallow water Processes Open University Course Team)

Diurnal tides



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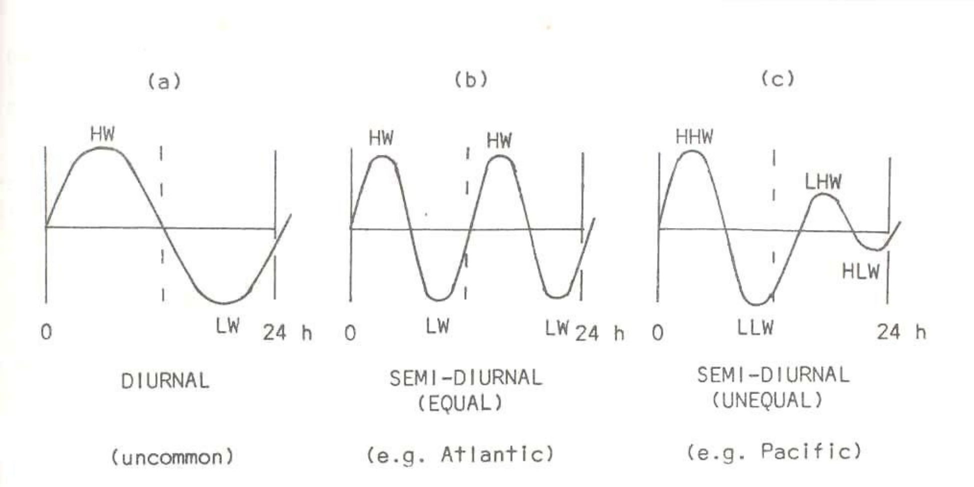
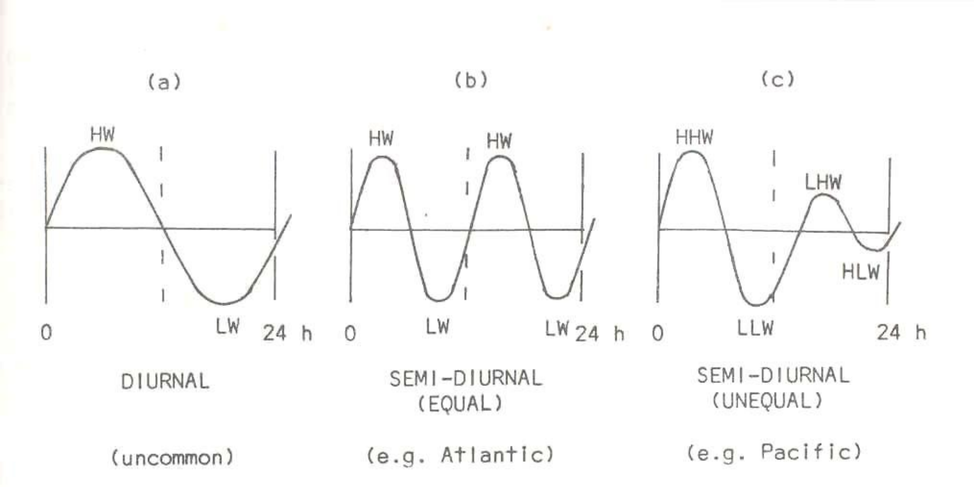


Diurnal vs. semi-diurnal tides

- Diurnal or daily tides - have a single high tide & a single low tide per tidal day
- Semidiurnal or semidaily tides - have two high tides & two low tides of approximately equal height each tidal day
  - Semidiurnal tides may have daily inequity, where successive high tides have different heights
  - Semidiurnal tides often easy to predict because high (or low) tides occur a consistent length of time after the moon has passed overhead



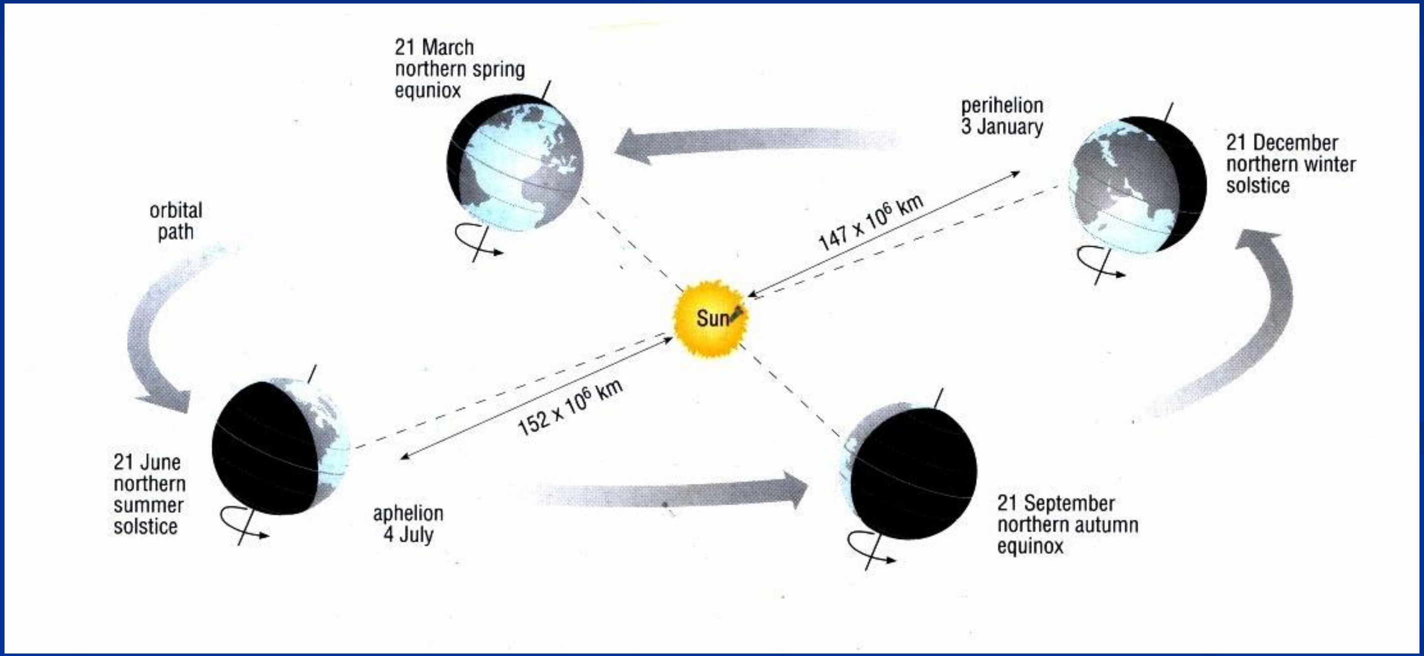
Mixed tides

- When heights of two successive high tides or two low tides are markedly different, we have a mixed tide
  - Identify higher high water tide (HHW), lower high water tide (LHW), higher low water tide (HLW), & lower low water tide (LLW)
  - Times of high stands & low stands are not simply related to passage of moon overhead

Relative importance of Diurnal and Semi diurnal tides

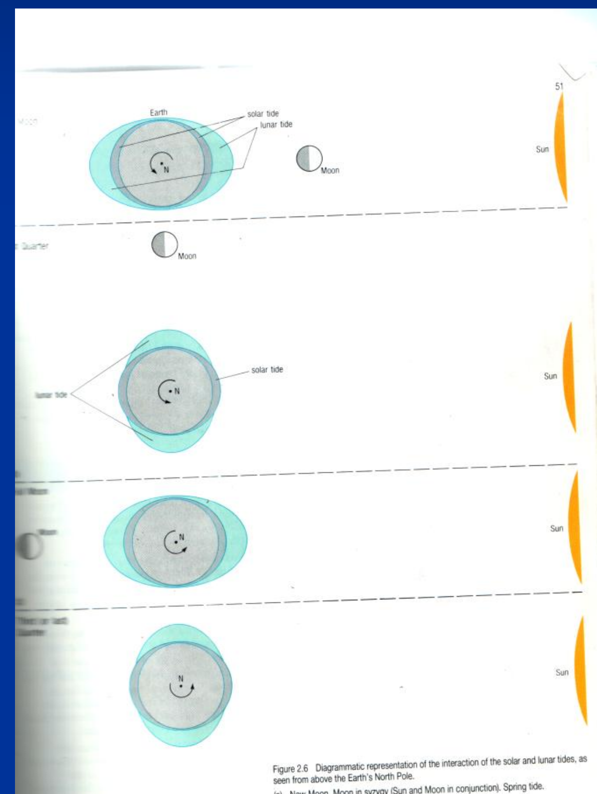
- Defined in terms of Form Number $F=(K_1 + O_1)/(M_2 + S_2)$
- Where the numerator denotes the amplitude of K1 and O1, while the denominator indicates the amplitudes of M2 and S2
- Semi-diurnal type, if F=0 to 0.25
- Mixed, mainly semi-diurnal, if F = 0.25 to 1.5
- Mixed, mainly diurnal type, if F=1.5 to 3.0
- Diurnal tides, if F > 3.0

Solar declination



Spring -Neap Cycle

During spring tide,
 tractive forces
 are aligned in
the same
direction
and during neap tide,
they are
Perpendicular
(quadrature)
cycle



Tidal ranges in spring tide, age of tide

- Mean spring range = $2(H\ (M2) + H\ (S2))$
- Mean neap range = $2(\ H\ (M2) – H\ (S2))$

- Age of tide = $g\ (S2)- g\ (M2\ )/(\omega\ (S2) – \omega\ (M2)$
- In practice, the delay is 36 to 60 hours after syzygy (moon and sun become in phase)

Tidal ranges during spring and neap tide

- Mean range = 2M2
- Spring range = 2(M2+S2)
- Neap range = 2(M2-S2)
- MHWS =Z0+ (M2+S2)
- MHWN = Z0 + (M2-S2)
- MLW S = Z0 –(M2+S2)
- MLWN = Z0- (M2-S2)

Luni-tidal interval

- This is the time lag for the occurrence of high tide at a place after the transit of the moon
- Mean high water interval = κ (M2)/m2
- Where κ is the local phase and m2 is the speed of M2 (this is applicable to regions dominated by semi-diurnal tides)
- If the moon's transit is taken from the greenwich time,
- MHWI =g(m2)/m2

Suggested Reading

- Pond S. and Pickard G.L. (1978). Introductory Dynamical Oceanography. Pergamon Press. 329 pp.
- Open University Course Team (1989). Waves, Tides and Shallow-water processes. Open University Walton Hall, Milton Keynes, MK7 6 AA, ENGLAND, Butterworth Hinemann, 187 pp.