

Q. Distinguish b/w ocean currents and Ocean Tides. Discuss the important types of tides and their origin.

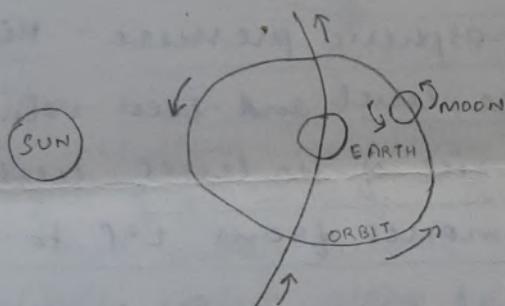
Ans - Ocean current is general movement of ~~a mass of~~ a mass of oceanic water in a definite direction, whereas Ocean Tide is rise and fall of seawater due to gravitational forces (centripetal) of the sun and the moon.

~~Cause of~~

Difference on the basis of cause of generation

Cause of Tide generation:

Gravitational force of sun and moon.



Similar directions of rotation & revolution of the earth and moon.

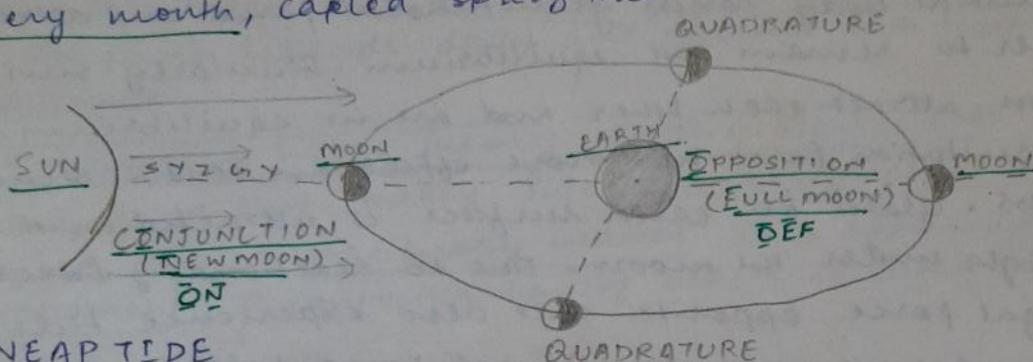
Earth rotates from west to east and revolves round the sun following an elliptical orbit, similarly, moon rotates from west to east and revolves round the earth along elliptical orbit. Therefore distance between moon and earth changes during different times in every month. At apogee 20% lower than average and at perigee, 20% higher than average tides occur. Moon dominates the tides because distance between moon and earth is far less than sun and earth so tide producing force of sun is  $390^3$  times less than that of moon.

## Cause of Ocean Current generation:

1. Gravitational forces - It cause vertical movement of ocean water. Greater value of gravitational force cause sinking and subsidence of water at poles.
2. Coriolis Force - It cause deflection of ocean current, right in northern hemisphere and left in southern hemisphere. Rotational force of earth cause movement of ocean water near equator ~~cause~~ <sup>in</sup> opposite direction to 'west to east rotation' of earth, generating 'Equatorial current', these current - move east to west, ocean water which moves in direction of rotation of earth is called counter equatorial current.  
map.
3. Difference in atmospheric pressure - high pressure cause lowering of sea level and low volume of water, and low pressure cause rise of sea level with high volume of sea water. water moves from L.P to H.P area.
4. Wind and Frictional Force - Steady wind through friction drives surface water and surface water exert friction and drags lower layer. Eg: Trade wind drive Equatorial current from east to west. winds cause upwelling, downwelling and piling of water.  
map.
5. Density difference - It is caused by evaporation, precipitation, melting of snow, meeting of river. Evaporation increases salinity and density and causes water to sink and insulating less dense water to take its place. Eg: movement of water from Atlantic ocean to Mediterranean sea.
6. Shape of Coastline - ocean current is modified by this. Eg: Equatorial current is bifurcated by obstruction of Brazilian coast into Gulf Stream & Brazilian current.  
map.

There are various types of tides produced because of variations in the intensity of tide producing force. They are following: -

1. SPRING TIDE - when moon is between sun and the earth (Conjunction), produces New moon, when earth is between sun and the moon (Opposition) produces a Full moon. Due to Syzygy position tide producing force of sun and moon are added causing Very high tide, twice every month, called spring tide.



2. NEAP TIDE

When moon is at right angle to the sun relative to earth (Quadrature) It is half way between New moon and Full moon i.e. 7th day of every fortnight of the month, tide producing force of sun ~~and moon~~ and moon work in opposite direction producing low tide called Neap tide.

3. TROPICAL & EQUATORIAL TIDES - when there is maximum declination of moon to north of equator, moon's rays fall vertically on Tropic of Cancer, producing spring tide, also caused along Tropic of Capricorn. Such tides are called Tropical tides. There is great difference between height of two high and two low tides called diurnal inequality of tides. When moon is above equator height of two high and low tides are similar, called Equatorial Tides.

4. APOGEAN AND PERIGEAN TIDES - when moon is in nearest position to earth i.e. Perigee, tidal force is most powerful causing Perigean Tide and when moon is in farthest position to earth i.e. Apogee, tidal force is minimum causing Apogean Tide. when they coincide with spring or neap tide, tide become abnormal Eg: Gulf of Fundy.

5. DAILY AND SEMI-DIURNAL TIDES - Tides occurring at interval of 24hr 52min - DAILY TIDES and at interval of 12hr 26min - semi diurnal tide.

6. EQUINOCTICAL SPRING TIDES - Tides occurring at an interval of 6 months due to revolution of earth around sun.

### ORIGIN OF TIDES

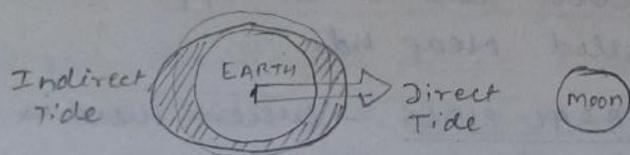
Numerous theories have been put forth to explain origin of tides.

1. Equilibrium Theory of Isaac Newton (1687) -

Every celestial body possess gravitational force and attract each other to remain in equilibrium. Similarly sun, earth and moon attract each other and are in equilibrium.

Lunar gravitation force has more effect on earth because of nearness. Water on earth surface is attracted and pulled high under the moon. Due to reactionary force i.e centrifugal force opposite side also experience tide.

Gravitational force and Centrifugal force balance each other along line joining both the poles, resulting in a force directed towards centre of earth. It cause low tide.



Limitation - 1. Earth surface is composed of land & water so gravitational force of moon will not be so effective.

2. For bulging of seawater outward horizontal movement of tide is needed.

3. Time of high tide is never same at all places along each meridian. For eg: Liverpool & Leith (at 80°W long), time difference of high tide - 3 hr.

4. Time taken by tidal waves to move round earth will be more because of configuration of coast of different oceans and depth. But tidal waves are not free but forced waves obstructed by continental and oceanic barriers.

2. Progressive Wave Theory of William Whewell (1883) -

Assumptions :

1. Earth, a heterogeneous body

2. Tides occur at different ~~place~~ time at different places on the same longitude.

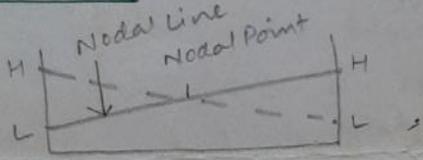
- Lagging of time of tides away from source.
  - 4. Variation in magnitude and amplitude of tides at different places.
  - 5. Tide is in form of Tidal waves which travel east to west.
- Tidal waves generate in southern ocean in southern hemisphere, called Primary waves. Due to obstruction by continents are refracted northward and called Secondary wave (derived waves). Magnitude and amplitude decrease from south to north.

- Criticism - 1. Time of Spring Tide is same from Cape Horns to Greenland in Atlantic ocean.
2. Tides are local rather than phenomena originating in southern ocean and moving progressively northward.
3. At some latitude daily and semi-diurnal, both type of tides are observed.

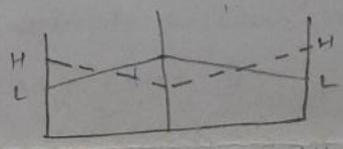
3. Stationary Wave Theory of R.A. Harris (1904) -

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According to this theory tide is a regional phenomena caused due to stationary waves. It is explained by an experiment. A container having water if tilted water level



Unimodal Oscillation System



Bimodal Oscillation System.

rise along one side and fall along other. It generates oscillation in water called stationary waves. Similarly different oceans are like containers have water. Tidal force of sun and moon cause oscillation but it occur around a central point because of rotational force of earth so several amphidromic points are generated. At these points water remains stationary and water level changes around them. So waves form which move in anticlockwise direction. Oscillatory system is affected by depth, configuration, length of ocean basins and rotational speed of earth. waves move towards coast, their crest and troughs cause tides and ebbs respectively.

Thus, of all the theories regarding origin of tides the stationary wave theory offers almost satisfactory explanation for local differences in tides, their types and their age. However, research in connection with the characteristics of tides is still in progress in various tidal institutes all over the world.

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