



## DEFINITION:

- ❖ Tides are periodic rises and falls in the level of the sea, and are formed by the gravitational attraction of the Moon and Sun on the water in the ocean.
- ❖ Although the Moon is much smaller than the Sun, it has a greater gravitational attraction for the Earth because the Moon is much closer to Earth. This causes the oceans to bulge out in the direction of the Moon.

# HISTORY

- Earliest explanation given by Galileo Galilee in 1632 -*Dialogue on the Tides* (theory was however incorrect - he attributed tides to water sloshing due to Earth's movement around Sun).
- About same time, Johannes Kepler correctly suggested that Moon caused tides.
- Isaac Newton in 1686 first explained tides scientifically with mathematical explanation of tide-generating forces, in *Principia* Volume 2.
- Academie Royale des Sciences, Paris, offered a prize for best theoretical essay on tides to Daniel Bernoulli, Leonhard Euler, Colin Maclaurin & Antoine Cavalleri in 1740,
- Jean le Rond d'Alembert, 1744, studied tidal equations for the atmosphere excluding rotation.
- Pierre-Simon Laplace formulated a system- Partial differential equations, that relates ocean's horizontal flow to its surface height, the first major dynamic theory for tides. Laplace tidal equations are still used today.

# Significance of Tides

- Make marine environment a unique landscape in earth.
- Enable nutrients, temperature & other ecological variables to distribute all over marine environment uniformly.
- In coastal zones, they dissipate huge amount of energy.
- By virtues of its amplitude, dimension & intensity, determines many geomorphological features.

# TIDAL PHENOMENON

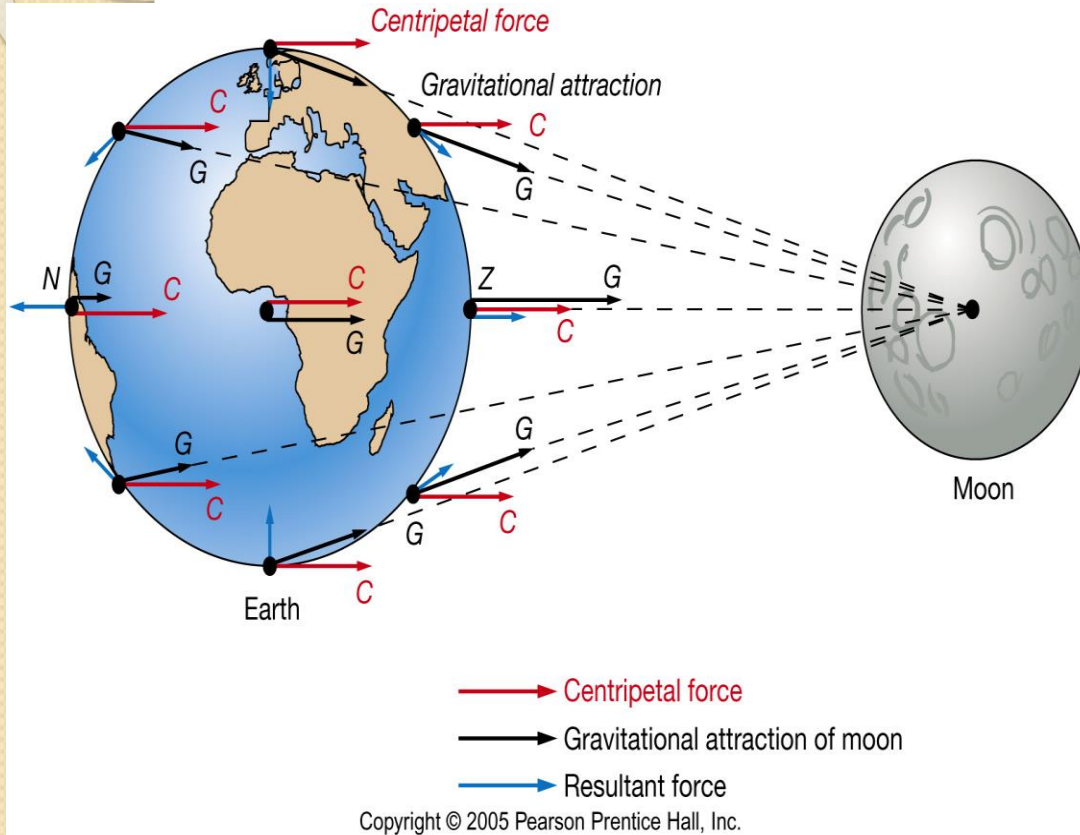
- The tidal phenomenon is the periodic motion of the waters of the sea, caused by celestial bodies, principally Moon & Sun, upon different parts of the rotating earth.
- Sun's contribution to these forces, are negligible compared to that of the Moon.
- Although tide-producing forces are distributed evenly over the globe, variations on size and shape of ocean basins, as well as the interference produced by land masses create differences in actual tidal current.
- The tidal patterns of a certain area are determined by its location in a certain basin.

# Causative agents:

- There are over 150 factors that can affect tide behavior.
- The greatest influences on tides are:
  - Coriolis effect
  - Landforms
  - Ocean depth

Coriolis force- type of force imparted on a body moving in a rotating direction. Called 'fictitious force' as it doesn't exert any real force itself, but, is a measurable output of a rotating object, due to inertia.

# TIDE PRODUCING FORCES..



- **Centripetal Force**  
The force by which bodies are drawn or impelled, or in any way tend, towards a point as to a center. ~Isaac Newton

- **Gravitational Force**

**Newton's Law of Gravitation**

$$F = \frac{GmM}{r^2}$$

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[G = universal constant of gravitation =  $6.7 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$ ]

- **Resultant Force**

## Some terms related to tide..

**Tidal inequality** = Difference in height between a high tide and the next high tide (or between successive low tides).

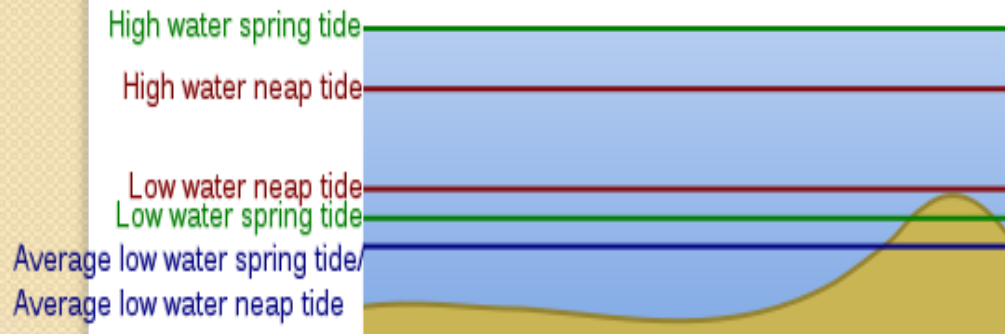
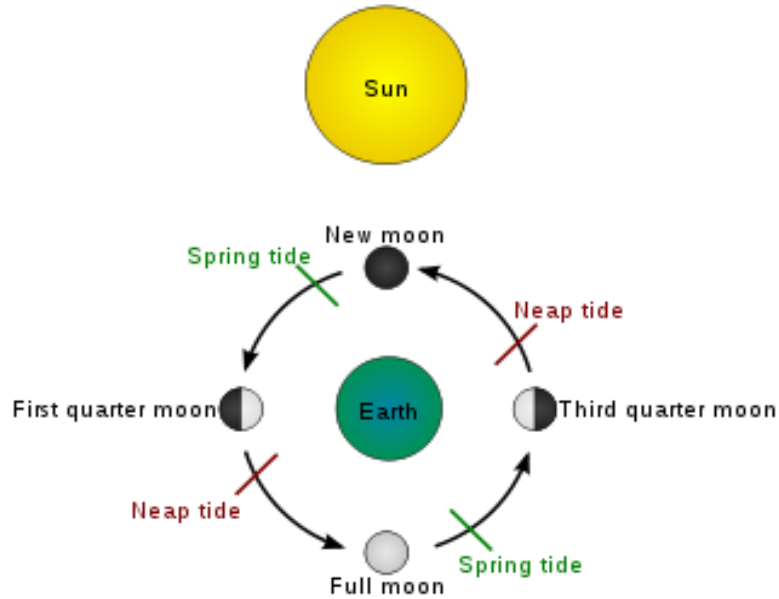
**Tidal curve** = Plot of water surface height vs. time (daily, monthly).

**Tidal period** = Time between 2 successive high tides (or 2 successive low tides).

**Tidal range** = Difference in height between a high tide and the next low tide (or vice versa).

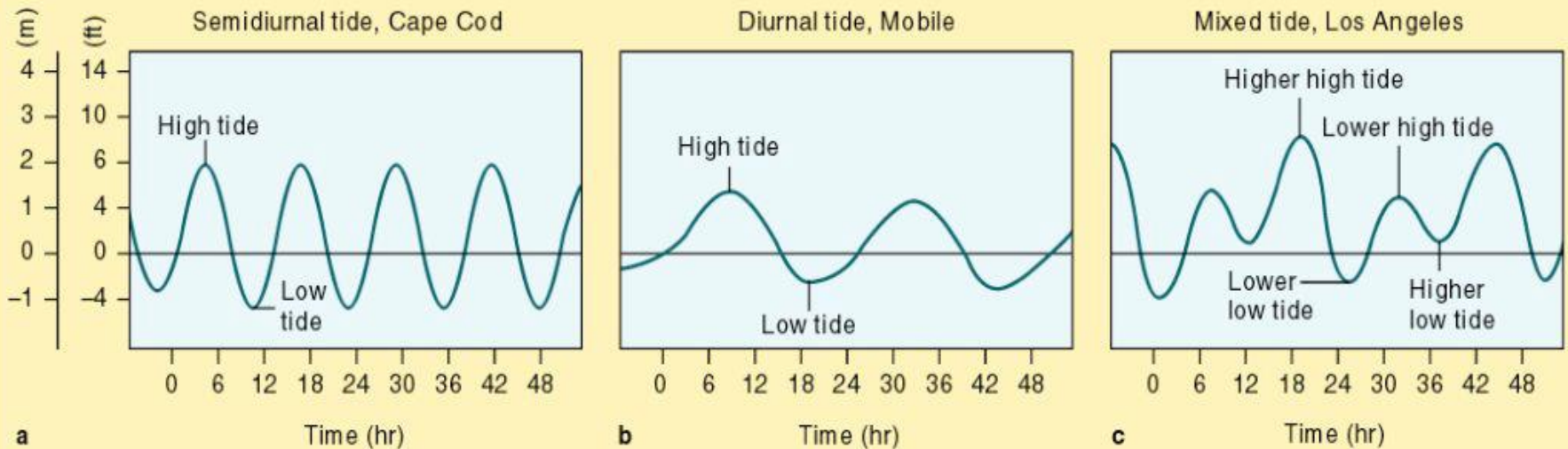


# TYPES OF TIDE (Contd.)



- **Spring Tide:**  
Every 2 weeks;  
Sun & Moon in same line;  
High high-tides & Low low-tides.
- **Neap Tide:**  
Midway in fortnight;  
Moon in equators;  
Lowest tides & minimum difference between tides.

# TYPES OF TIDAL CYCLES/ PATTERNS




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- **Semi-diurnal Tide:** 2 high and 2 low waters of similar ranges occur daily when the moon is over the equator.
- **Diurnal Tide:** 1 high and 1 low tide occur daily in certain areas when moon is furthest from equator.
- **Mixed Tide:** They also occur as the moon moves furthest north or south of equator. They are typified by large variances in tidal ranges during the two daily tides.

# TIDE PREDICTION

- In the uniform tidal system (semi and diurnal), the greatest height to which the tide rises on any day is known as high water and the lowest point is low water. In a mixed system, it refers to higher high and lower high water and higher low and lower low waters.
- Tidal observations made over a period of time are used to calculate the average or mean tide levels.
- Because the depth of coastal waters is important for navigation, an average low-water reference is established.

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- Tidal predictions are based on recorded high measurement from past records, and then are used to predict the future. With a combination of actual local measurements with known astronomical data, scientists can derive very accurate tide predictions.
  - Tide gage recording stations are installed at numerous coastal sites, which track the rise and fall of ocean waters.
  - A minimum of 19 years of records is needed.
  - Tide tables are published annually by the National Oceanic and Atmospheric Administration and give the dates, times, phases of the Moon, and ocean and water levels for high and low tide at numerous locations along the coast and inland on some bays and estuaries to the head of tidewater.

# TIDAL BORE

A tidal phenomenon in which the leading edge of the incoming tide forms a wave (or waves) of water that travel up a river or narrow bay against the direction of the river or bay's current. 'Bore' in Old English, means 'wave' or 'swell'.



**Tidal bore on the River Ribble**



**THE END**