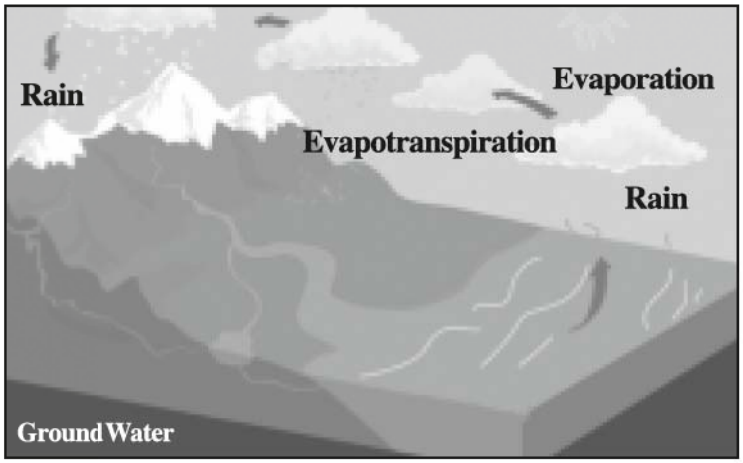
12 Hydrosphere

If we look at the surface of the earth, we can see more of water area than the land. Most of the earth is covered by water. That is why earth is also called a water planet. About 71 % of the earths surface is covered by water.

Water Cycle

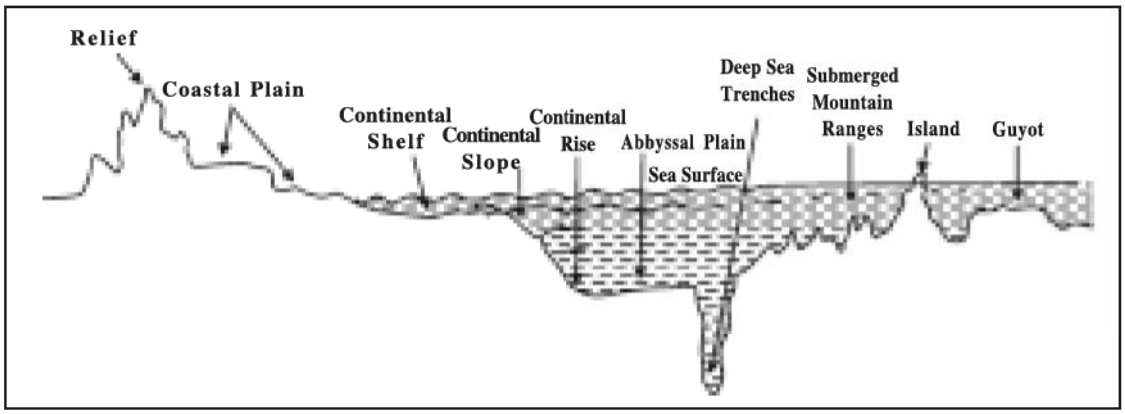
Water is found on the earth in solid, liquid and gaseous forms. Its form and location change according to favourable relief. Due to solar heat, the water from seas, lakes, rivers etc. turn into water vapour and clouds are formed. Condensation takes place under favourable conditions and these clouds give rain in more or less amount on all areas. Most of this water is emptied into seas and oceans through rivers. Ground water which is absorbed by the tree roots, merges into atmosphere through evapotranspiration. The process in which the ocean water is distributed in different areas as rain water and returns to the ocean is called **Hydrological Cycle.** Thus water circulates in atmosphere, lithosphere and hydrosphere.



12.1 Hydrological Cycle

Relief Features of the Ocean Floor

Ocean floor is not uniform everywhere. Just as there are major landforms like mountains, plains, plateaus and valleys on land, the ocean floor also has identical landforms. These are divided into four parts : (1) Continental Shelf (2) Continental Slope (3) Abyssal (Deep Sea) Plains (4) Deep Sea Trenches



12.2 Relief Features of the Ocean Floor

(1) Continental Shelf : The plain region up to a depth of 200 metres (100 fathoms) near the coasts of seas and oceans is known as **Continental Shelf**. It covers about 8 % of the ocean floor. Slope from the coast towards the sea gradually increases. Continental shelves are found having different width. It is about 15 to 20 km wide on the western coast of South America, is 80 to 120 wide on

the eastern coast of Africa and has a width of about 500 km in Arctic Ocean. An average width of continental shelf on the entire ocean floor is 65 km and the depth is about 130 metres. Continental shelf starts from the coast and terminates at the continental slope. As sunshine can reach up to a depth of 200 metres (600 feet) many marine vegetation and animal life have flourished in the continental shelf. Many fishery centres also have developed in continental shelves.

Like to know :

Depth of the ocean is measured in fathoms.

1 fathom = 6 feet abovt 1.8 meters

(2) Continental Slope : When the continental shelf ends, the depth of the ocean suddenly increases. This slope which starts from the edge of continental shelf is called **Continental Slope**. It extends up to deep sea plains. It is a transition between continental shelf and deep sea plains. According to geologists, continental slope is formed due to either faulting or folding processes.

(3) Deep Sea Plains : At the end of continental slope, a vast plain of the sea floor starts. Here the submarine relief becomes more smoother. These vast plains are formed at a great depth from the sea surface, so these are called Deep Sea Plains. These plains cover about 76 % area of the sea floor. Average gradient here is 1^0 and an average depth is 6000 metres. These plains are located very far from the sea coast and also at a greater depth. Maximum plain area is in Pacific Ocean. In Atlantic Ocean, there are more continental shelves, so plains occupy lesser area. As deep sea plains are located many km away from the coast, the alluvial deposits cannot reach there. So most of the deposits on these plains are the residues of marine life and volcanic substances.

(4) Submarine Trenches : Deep Sea Trenches are the deepest area of ocean floor. They are of arc shape and are narrow. They have a wall like slopes. At some places in deep sea plains, the slope becomes steep suddenly, so narrow, deep and long valleys are formed there. There is a deep sea trench known as **Mariana Trench** in Philippines Islands in Pacific Ocean and it is more than 11000 metres deep at its maximum.

Temperature of Sea Water

Temperature of sea water is an important physical property. Sea water warms up due to solar radiation. Sunrays cannot penetrate below 200 metres in sea. So generally the upper surface of the sea is warmer and most of the lower part remains cool. Average surface temperature of oceans water is 17^0 C.The sea surface temperature of Pacific Ocean is 19^0 C and that of Indian Ocean is 17^0 C. The average surface temperature of Atlantic Ocean is 16.9^0 C.

Factors affecting the temperature of sea water :

Angular height of sun, geographical location, area and shape of oceans, winds, ocean currents, relief of sea floor etc. affect the temperature of sea water.

(1) Angular Height of the Sun : The surface temperature of oceans in equatorial region is more because of lower angle of sunrays, while the angular distance is more over polar regions, the sunrays cross more distance to reach the sea surface. This results in lower sea surface temperature on polar

regions. Generally, the sea surface temperature decreases from equator to poles. The decrease is @ 0.5^0 C for every latitude.

(2) Geographical Location, Area and Shape of sea : The temperature of landlocked and marginal seas is either more or less than the open seas. It is dependent on the sub-merged mountain ranges and coastal land. There is an impact of nearby continents on Baltic Sea and Hudson Bay, so their temperature is lower than the open seas. Red Sea is surrounded by deserts and so high temperature prevails over there.

(3) Winds : Due to the cold winds blowing over from continents, there is an annual difference of about 18^0 C in the temperature of North Pacific and North Atlantic Oceans. The South-Western Monsoon winds blowing over India in summer raise the sea water temperature, while the North-East Monsoon winds blowing during winter decrease the sea water temperature. Thus winds change the sea water temperature.

(4) Ocean Currents : Currents have a dominant effect over the sea temperature, e.g. the warm Gulf Stream current increases the sea surface temperature of Atlantic Ocean, while the cold Labrador current reduces the temperature.

Salinity of Ocean Water

Sea water tastes salty and this salinity is due to the salts dissolved in it. These salts include salt, calcium, magnesium etc., wherein there is an excess of salt. The ratio of the dissolved salts in sea water is called Salinity. The salinity is the weight of the solid substance in the 1000 th part of sea water. Salinity is shown in $^0/_{00}$ (per one thousand gram) unit. The average salinity of sea water is 35 $^0/_{00}$, i.e. there is 35 gram of salt in every 1000 gram of sea water.

Factors affecting the salinity of sea water :

The salinity of sea water depends on its density, temperature, addition of fresh water, evaporation, ocean currents, melting of glaciers, rivers etc.

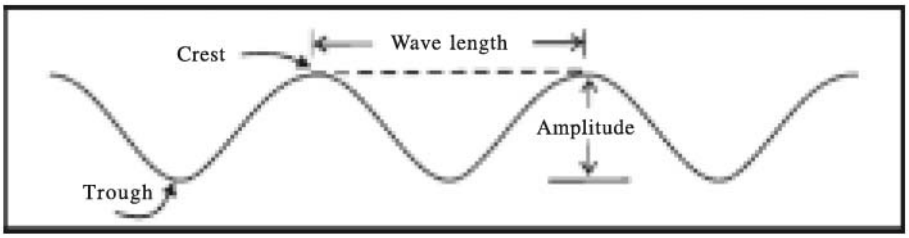
If the sea water is more dense, the salinity is also more. Higher temperature means more of evaporation, which will increase the salinity. Milder the evaporation lesser will be the salinity. In tropical regions there is more salinity. Dry and hot winds increase the evaporation in Red Sea and Mediterranean Sea, so salinity of Red Sea is 41 $^0/_{00}$ while the salinity is 39 $^0/_{00}$ in Mediterranean sea.

The salinity of sea water near the mouth of rivers Congo, Amazon, Sindhu, Ganga etc. decreases due to the addition of fresh water. In some seas in Temperate zone and Polar region, fresh water from melted glaciers is added to the sea water so the salinity of sea water is decreased. Cold currents reduce the salinity while warm currents increase it. Salinity in sea water of Western Europe increases due to the warm current of North Atlantic Ocean while cold Labrador Current reduces the salinity of eastern coast of North America.

Movements of Sea Water

Sea water is dynamic constantly. We can see its movements in the form of currents flowing in a specific direction or through its oscillation. Due to the oscillations, sea water moves to and fro as well as up and down. Such movements of sea water may be termed as **Motions** of Sea Water. On the basis of volume, extent etc. the movements of sea water can be divided into three forms : (1) Sea waves (2) Tides and Ebbs (3) Ocean Currents.

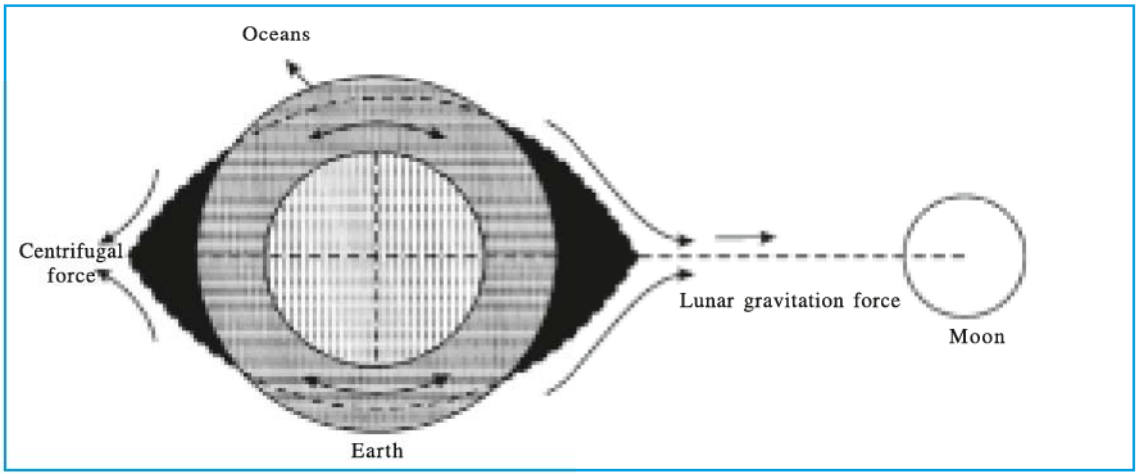
(1) Sea Waves : Surface water of the sea moves to and fro as well as up and down and is constantly active. This to and fro and up and down movement of sea water is called sea waves.



12.3 Sea Waves

Sea waves are created due to winds. These waves originate because of small breezes to stormy thunderstorms. Factors like coriolis force of the earth, gravitational force by sun and moon, earthquakes taking place on ocean floors, volcanic eruption etc. affect the sea waves.

(2) Tide and Ebb : Systematic rise and fall of sea surface is called **Tide and ebb** . The gravitational forces of sun and moon are major factors for tide and ebb. At the time of tide, the sea water dashes towards the coast and the water level rises. The sea water moves back towards the sea during ebb and so the water level recedes. Generally, tide and ebb happen twice during one day. The time duration between two successive tides and two ebbs is 12 hours 25 minutes. So for two tides and ebbs, it takes about 24 hours and 50 minutes. Every day, a tide or an ebb occurs late by 50 minutes than the previous day. However, this daily phenomena of tide and ebb is not experienced uniformly in all seas. There is only one tide-ebb in Gulf of Mexico during 24 hours 50 minutes.



12.4 Tide–Ebb

Types of Tide

Spring and Neap Tide : On every full moon and new moon, the sun, earth and moon happen to be in a straight line. Due to the gravitational force of the sun and the moon, very high waves are formed so a large tide occurs. This is called Spring Tide. On the eighth day of Lunar month, the sun and the moon happen to be at right angle so they exert less gravitational force. As a result, a small tide occurs which is called Neap Tide

Along most of the sea coasts, tides and ebbs occur twice a day. These are called **Semi Diurnal Tides**. If a tide occurs only once a day, then it is called **Diurnal Tide**. Such diurnal tide occurs in Gulf of Mexico and along the West Australian coast.

Along the sea coast near Okha in Gujarat, tidal waves rise up to 2.5 metres height. Tidal waves in the Bay of Fundi rise up to about 15 to 25 metres height, which is highest in the world.

Tidal Bore : In some river estuaries sea waves rush against the riverflow like a wall. This is known as Tidal Bore. Hongzou in Qiantang river of China experiences greatest tidal bore of the world. The greatest tidal bore in India is on Ganga (Hugli) river near Kolkata.

Importance of Tide : Tide is very much useful to man. At many places, large ships can be brought near the shore during spring tide. The ships can come inside during tide and go out during ebb at some estuarine ports. Fishermen plan their visit to seas according to the time of tide and ebb. Ports and harbours remain clean due to tide and ebb. Tidal waters have tremendous power. Electricity can be generated from them. France, U.S. and Russia generate much electricity from tidal power. Tidal water is diverted toward smooth coast to produce salt.Thus tide is useful to man in many ways.

(3) Ocean Currents : A vast water mass which flows continuously in a definite direction at a specific temperature is known as an **Ocean Current** . It flows like a river in the ocean. Its course of flow is definite and permanent. These currents flow up to a certain depth from the surface and also from the sea floor to the surface. These currents are distinct at few places in the oceans. Ultimately, these currents are a large scale movement of water in the oceans. Currents are either cold or warm.

Reasons for the Origin of Ocean Currents

Solar heat, prevailing winds, coriolis force are main reasons for the origin of ocean currents. Solar heat brings changes in temperature, salinity and density of ocean. The solar radiation on the equator is vertical throughout the year. So the water in equatorial regions is warmer than on the poles. This warm water expands and so its surface is raised near equator compared to polar regions and forms a slope towards the poles. This enables the equatorial water to flow towards north and south pole. This is how the warm current starts. The water of polar regions is cold and more dense, so it flows towards equator as sub-surface current. This initiates cold current. This way, the difference in the temperature and density of surface water of the oceans give rise to warm and cold currents.

Permanent winds blowing from over the oceans give speed to currents. The currents sometimes deflect due to winds. Generally, warm currents flow from equator to poles and cold currents flow from poles to equator.

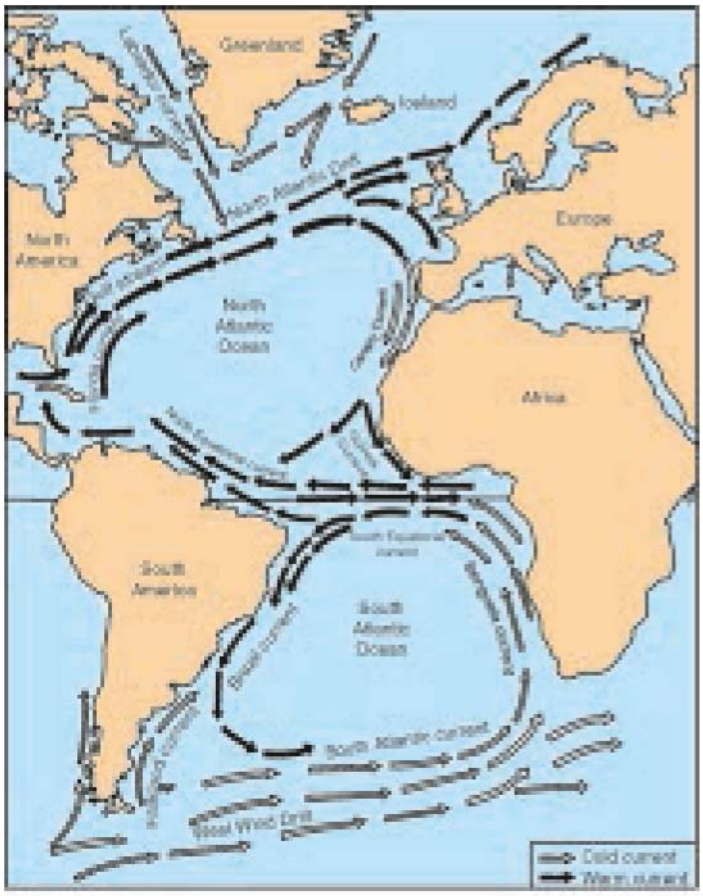
Major Ocean Currents

Warm and cold currents flow in every ocean. Independent and identical current systems are formed on either side of the equator in Pacific and Atlantic Oceans. An independent current system has developed in Indian Ocean also.

Currents of Atlantic Ocean

In Atlantic Ocean, North Equatorial Warm Current and South Equatorial Warm Current originate near the equator. Both these currents flow westwards.

(1) North Equatorial Current : This warm current initially flows east to west. It deflects near Florida and surges ahead in north-east direction. Here it enters the Gulf of Mexico and then is known as Gulf Stream. Near Canada, a cold Labrador current coming from north polar region meets Gulf Stream. One branch of Gulf Stream flows to east after Newfoundland. It bifurcates near west European coast. One branch flows towards Iceland and Norway in north. Other branch touches U.K. coast and flows along Spain and North-West African coast. It is known as **Canary Current** there. Finally it merges into North Equatorial current and completes a circle. This is a cold current.

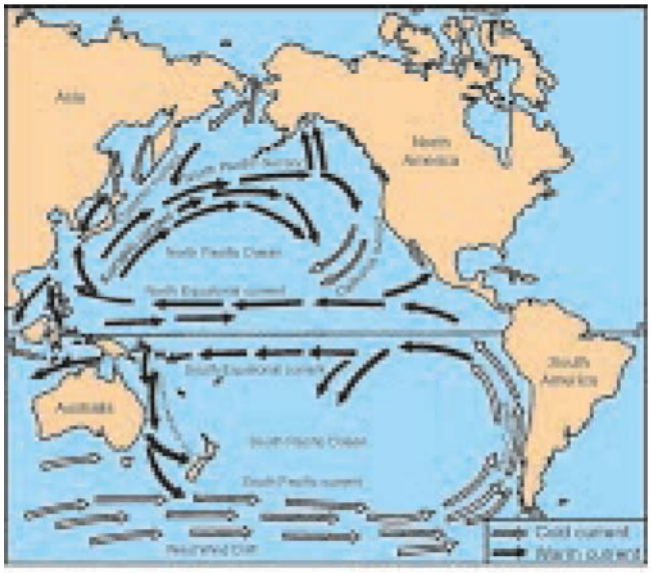


12.5 Currents of Atlantic Ocean

(2) South Equatorial Current : This current flows in anti-clockwise direction to the south of equator. It has again two branches : One branch moves northwards and merges into North Equatorial Current, while the second branch moves ahead in south-west direction and flows along the eastern coast of South America as Brazilian Current. The West Wind Drift crosses Atlantic Ocean and flows northwards as cold Benguela Current, merges with South Equatorial Current and completes the circle.

Currents of Pacific Ocean

The current system of this ocean resembles to that of Atlantic ocean. Here also, North Equatorial Warm Current flows to west. Near the western coast of Pacific ocean, it branches into two currents. One branch turns to north and surges ahead on the eastern coast of Taiwan and Japan. Here it is known as **Kuroshio** current. It flows further eastwards and reaches western coast of Canada, where it is divided into two branches near Vancouver. Its northern branch is called **Aleutian** Current and the other current going to south is known as Californian Current. This cold current ultimately meets the North Equatorial Current.

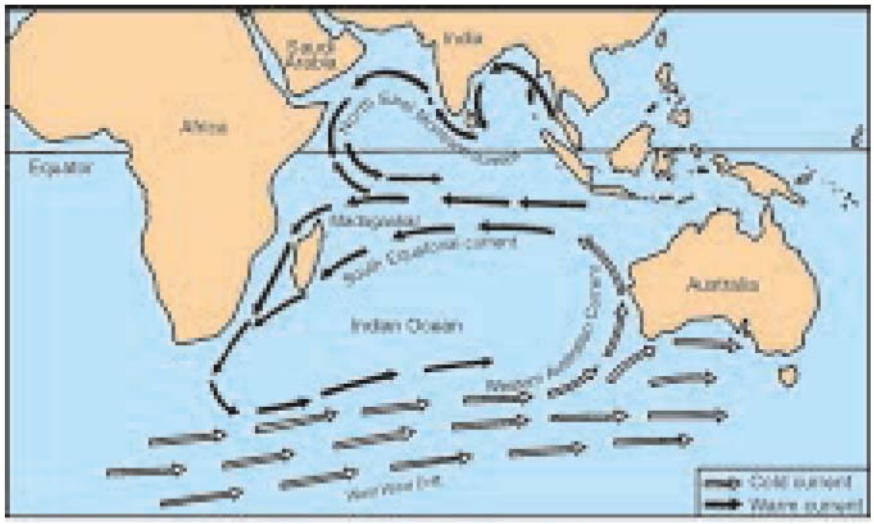


12.6 Currents of Pacific Ocean

There are innumerable islands in South Pacific Ocean. So the South Equatorial Warm Current does not flow uninterruptedly but is scattered into many small and large currents. Its main current flows southwards and is known as East Australian Current. This warm current meets the cold Western Current from south. Flowing eastwards, this current reaches up to Chilean coast of South America, where it is known as Peru Current or Humboldt Current.

Currents of Indian Ocean

Greater part of this ocean lies in southern hemisphere. It has less area in northern hemisphere. So there is more impact of the shapes of the continents which surround the Indian Ocean.



12.7 Currents of Indian Ocean

Here, the North Equatorial current flows westward and its counter current in winter flows in eastern direction. During summer, these currents become almost stationary, and in its place a north-east monsoon current starts from the east. Monsoon winds have a clear impact over these currents.

In Indian Ocean, South Equatorial Warm current flows westwards throughout the year. On reaching Africa, this current branches into two currents. One branch merges in the north with the **Somali** Current near Somaliland. The southern branch again bifurcates into two branches. One of this branches flows through Mozambique Channel where it is known as **Mozambique** Current. The other branch flows in the east of Madagascar Island and is known there as **Agulhas** Current and reaches up to western Australia. Here it is known as **West Australian** current. After flowing parallel to the coast it merges with South Equatorial Current.

Impact of Ocean Currents

Ocean currents hold much importance for man. Warm currents carry away the heat of equatorial region to much distance in north and south, while the cold currents transform the cold of polar regions to equatorial area. This way, ocean currents maintain the equilibrium of sea water temperature. Warm currents bring rain to some regions. Warm currents keep the temperature of cold coastal regions of higher latitudes warmer. Western European ports can operate even during winter due to the warm Gulf Stream. The confluence of warm and cold currents have become ideal regions for fisheries. Thus, ocean currents are useful to man in many ways.

EXERCISE

1. Answer the following in details :

(1) State the factors affecting the temperature of sea water and discuss in details.

(2) Explain in details the currents of Atlantic Ocean.

(3) State the relief of sea floor and explain each of them.

2. Write short notes :

(1) Hydrological Cycle (2) Abyssal Plains

(3) Spring and Neap Tide (4) Importance of Tide

(5) Impact of Ocean Currents (6) Salinity of Ocean Water

3. Give geographical reasons for the following :

(1) Temperature of Red Sea remains higher.

(2) Ocean currents affect the temperature of sea water.

(3) European ports remain busy even during winter.

4. Answer the following in one-two sentences :

(1) Due to which reason is the continental slope formed ?

(2) Where in the world are the maximum deep sea trenches located ?

(3) State the factors affecting the temperature of sea water.

(4) Where and how much high do the waves rise in the world ?

(5) Where in the world does the biggest Tidal Bore occur ?

5. Select the correct option from the following options and write answer :

(1) How much of the earth does the hydrosphere cover ?

(a) 21 % (b) 78 % (c) 71 % (d) 50 %

(2) On which relief feature of the ocean floor can the sunshine reach ?

(a) Continental Slope (b) Abyssal Plain (c) Sea Trenches (d) Continental Shelf

(3) Which ocean coast has the widest continental shelf ?

(a) Indian Ocean (b) Arctic Ocean (c) Atlantic Ocean (d) Pacific Ocean

(4) Which is the deepest ocean trench in the world ?

(a) Mariana Trench (b Tonga Camdic (c) Puerto Rico (d) Andaman

(5) What is the average surface temperature of Atlantic Ocean ?

(a) 17° C (b) 19° C (c) 16.9° C (d) 19.9° C

(6) Which is the main factor causing the origin of sea waves ?

(a) Ocean current (b) Temperature (c) Wind (d) Salinity