3. Tides

Can you tell?

Observe the following pictures. Answer the questions given below and discuss.

Figure 3.1 a

Figure 3.1 b

- Do the above photographs show the same place or different places?
- Observe and note the spread of water seen in both the photographs.
- What is this natural event called?

Geographical explanation

Both the photographs show the same place. If you stay near the coast for some time, you will realize that the sea water is sometimes very close to the coast (Figure 3.1a) while at other times, it is far away from the coast. (Figure 3.1b) We call these movements of the sea water 'tides'. Barring a few exceptions, all the coasts on the earth experience tides. High and low tides are natural phenomena. Let us try to understand the scientific reason behind these natural events.

Tides are movements of sea water occuring daily and regularly. The level of sea water changes after a specific period of time. After every 12 hours and 25 minutes, a cycle of high tide and low tide gets completed.

This regularly occurring event appears to be quite simple and natural, however, it is directly related to the sun, the moon and the earth and the gravitational and centrifugal forces that interact between them.

Try this.

- Keep a small stone or a chalk piece on your notebook and move the notebook from left to right with some force.

Figure 3.2 : Girl moving a notebook with force

- Take water in a small container which has a handle. See what happens if the container is whirled around with force.
- Fill the mixer jars with water and switch on the mixer. Observe. (Do this under the supervision of parents.)
- Observe a fan and a slingshot while they are moving.

❖ Take half a glass of water. Slowly move the glass in one direction, in circular fashion. Observe what happens to the water.

Figure 3.3 : Boy moving the glass with water

❖ Observe what happens if you whirl a keyring around a finger.

Figure 3.4 : Girl whirling the keyring

Can you tell?

On the basis of the questions given below, discuss the results of the activities listed above.

- In which direction did the piece of chalk fall?
- Where did the water in the glass show a bulge?
- What effect did the movement have on the things attached to the keyring?
- What happened to the water in the container and the mixer?
- Which forces could be operating in activities listed above?
- In which activities did you find that the centrifugal or gravitational force was greater?

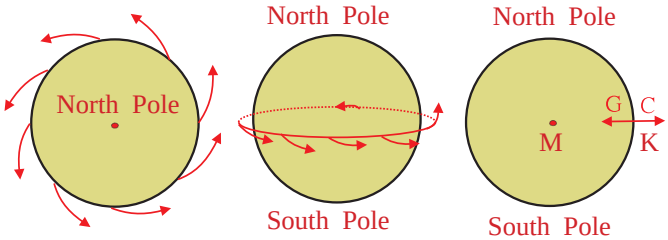
Geographical explanation

In all the above activities, the effect of the centrifugal force is visible. The centrifugal force acts in the direction opposite to the gravitational force. Centrifugal means going away from the centre. You must have experienced it too. At the local fairs if you sit in a Ferris Wheel, your seat spins and leans outward away from the wheel. This also is an effect of centrifugal force.

Divide the students into two equal teams. Conduct a game of tug-of-war for five minutes. Discuss their experiences in the class.

Centrifugal and gravitational force:

Due to its rotation, the earth gets a type of power or force. This force works away from the centre. It is called centrifugal force. (See fig. 3.5) Due to this force any object on the earth would be thrown into the space. However, the gravitational force is working towards the centre of the earth at the same time. This force is many times greater than the centrifugal force. Hence any object on the surface of earth remains at the place where it exists.



G= Gravitational force, C= Centrifugal force

Figure 3.5 : Centrifugal force and gravitational force

Tides:

The following factors are responsible for the occurrence of tides.

❖ The gravitational pull of the moon and the sun as well as that of the earth.

- Revolution of the earth around the sun and the indirect revolution of the moon around the sun.
- Centrifugal force generated due to the rotation of the earth.

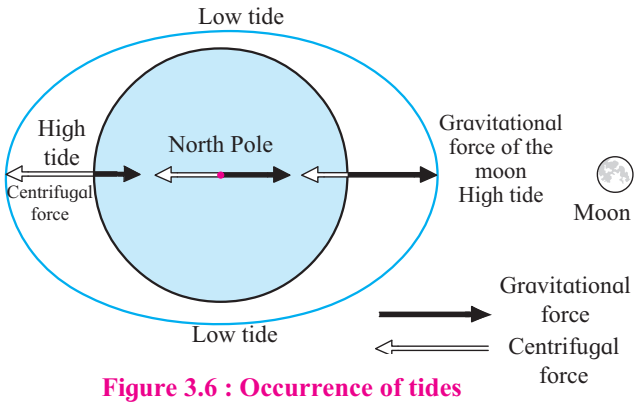


Figure 3.6 : Occurrence of tides

The moon is closer to the earth than the sun, hence its gravitational force becomes more effective than that of the sun. Tides occur due to the relative positions of the moon, the sun and the earth. A place on the earth located at the opposite point of the place experiencing high or low tide also experiences high or low tide respectively at the same time. This is a result of the centrifugal force. See fig. 3.6 and try to understand the locations of high and low tides on the earth.

- When there is high tide at 0° meridian, the 180° meridian also experiences high tide.
- The meridians that are at right angles to those having high tide will experience low tide at the same time. If it is high tide at 0° and 180° meridians, then at which meridians will low tide occur?

Think about it.

☞ Large rockets are used to go into the space away from the earth. Which force do they act against?

Types of tides:

As the timing of the tide varies every day, the range of a tide also keeps on changing. Generally the highest high tide occurs on full moon and new moon days whereas on the days of the first and the third quarter, the high tide is at its minimum. Spring tides and neap tides are the two types of tides.

Spring tide:

On new moon and full moon days, the gravitational pull of the sun and the moon act in the same direction. Due to this, the total pull increases. Hence the tide on these days is much higher than the average high tide. This is known as spring tide. See fig. 3.7. As the bulge at the high tide is greater, the water at low tide recedes much more. The water level during spring tide is higher than the average high tides and lower than the average low.

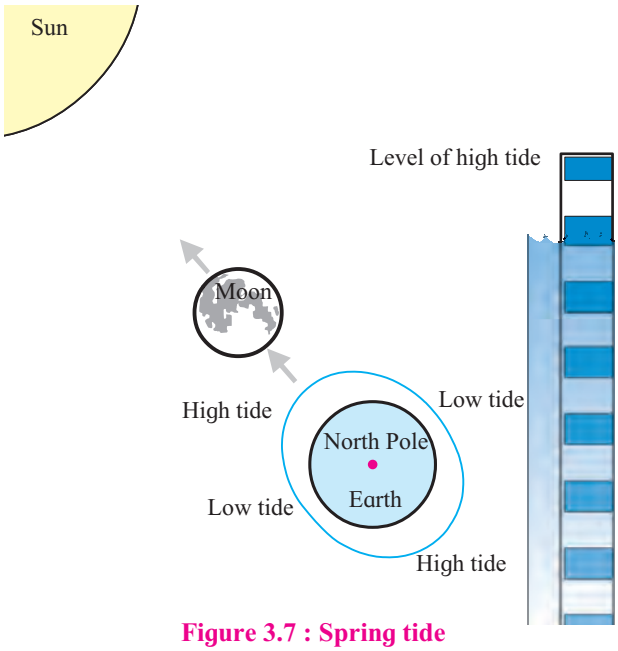


Figure 3.7 : Spring tide

Neap tide:

While revolving around the earth, the moon makes a right angle with respect to the earth and the sun, twice a month. This position occurs on the first and the third quarter of each month. On both these days, the forces of both the sun and the moon operate at right angles on the earth. See fig. 3.8. At the places where the sun causes high tide, the gravitational pull of the moon which is at right angles also acts on the sea water. Due to such conditions, the water level rise is less than usual at the time of high tide.

Similarly, fall in water level is less than usual at the time of low tide. This is because the attraction of the sun and the moon are not complementary but at right angles to each other. Such tides are called neap tides. Neap tides are a little lower than the average high tides and a little higher than the average low tides.

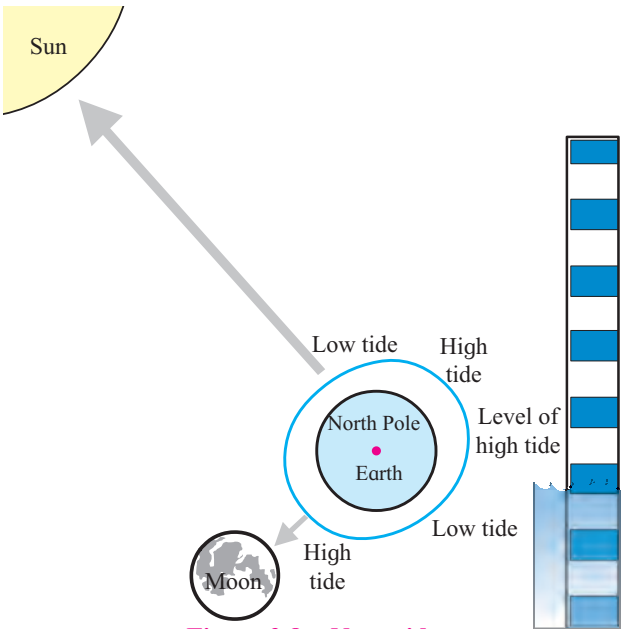


Figure 3.8 : Neap tide

Do you know ?

Intertidal Range

The difference in the water level of the high tide and the low tide is called tidal range. In open seas, this range is about 30 cm. However, towards the coastal areas it goes on increasing. Along the coast of Peninsular India the range is around 100 to 150 cm for most of the part. The highest tidal range in the world is observed at Bay of Fundy along the Atlantic Coast of North America. Here the tidal range is about 1600 cm. In India, the highest tidal range is in the Gulf of Khambhat. It is about 1100 cm.

Effects of tides:

- With the high tide, fish move into the creeks and this helps fishing activity.
- The tides clear the waste and hence the coasts become clean.
- Ports do not get filled with sediments.
- Ships can move up to the ports during high tide.
- During high tide, sea water can be stored in salt pans from which salt can be obtained.
- The tidal force can be used to generate electricity.
- A lack of an understanding of the timings of high and low tides may cause accidents to swimmers entering the sea.
- The tides help in maintaining the mangroves and the coastal biodiversity.

Timings of the tides change daily :

The tides are continuously occurring phenomena. After reaching the maximum water level during high tide, the low tide sets in. Similarly, after reaching the lowest water level during low tide, the high tide sets in. Remember that in the following discussion the highest limit of the high tides is mentioned. See fig. 3.9. You will understand why the timings of the high and the low tides change daily.

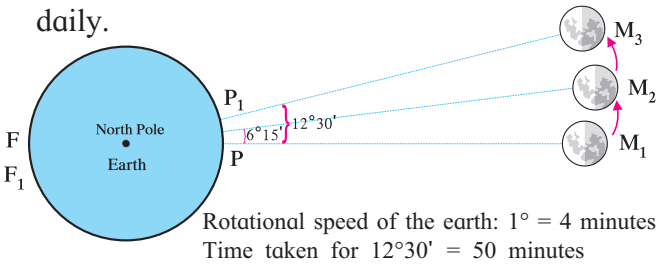


Figure 3.9 : Why do the tide timings change daily?

- There will be high tide at point 'P' as it is opposite to the moon.
- As point 'F' is opposite (at an antipodal location) to the point 'P', it will also experience high tide at the same time.
- It will take 24 hours for point 'P' to come back to its original position (360°). Point 'P' will be at point 'F' after 12 hours (180°).
- The same change will also occur with reference to the point 'F'.
- Point 'F' will not experience the same high tide, because in the meanwhile the moon also would have moved a little

ahead (approximately 6° 15'). Hence it will take 25 minutes more for the point 'F' to come to the position opposite to the moon.

- After 12 hours 25 minutes, 'F' will arrive opposite to the moon and it will experience high tide. Point 'P' opposite to 'F' will also experience high tide.
- Later again, after 12 hours and 25 minutes point 'P_1' will experience high tide as it comes in front of the moon. There will be high tide at F_1 too as shown in the fig. 3.9.

There is high tide and low tide twice a day (24 hours) generally. The time difference between two high tides is of 12 hours and 25 minutes.

Try this.

- Take a wide open large dish.
- Keep the dish on a table or a flat surface.
- Fill water in the dish up to the rim.

We have to generate waves in the dish.

- Is it possible to generate waves without touching or shoving the dish? Try doing so.
- In what different ways can you generate waves in the dish?

Geographical explanation

Waves:

If you blow air over hot milk or tea, while drinking, ripples are generated on the milk or the tea. In the same way, because of the force of the wind, water appears to be moving. The sea water gets pushed by the wind and ripples are generated on the water surface. These are called waves.

The sea water moves up and down or slightly forward and backward due to the waves. The waves bring the energy contained in them to the coast. They break in the shallow waters near the coast. Large or small waves are formed continuously at the surface of the sea. Generation of waves is a natural and regularly occurring phenomenon too. See fig. 3.10.

Figure 3.10 : Waves coming to the coast

Structure of the waves:

The sea water get pushed up and down because of the wind. The raised up portion of a wave is called crest and the depressed one is called trough. If a strong wind is blowing in one direction, large waves are generated.

The vertical distance between a crest and the following trough is called the amplitude of the wave whereas the distance between two successive crests or troughs is called wave length. The wave length, its amplitude and its velocity depend on the velocity of wind. See fig. 3.11.

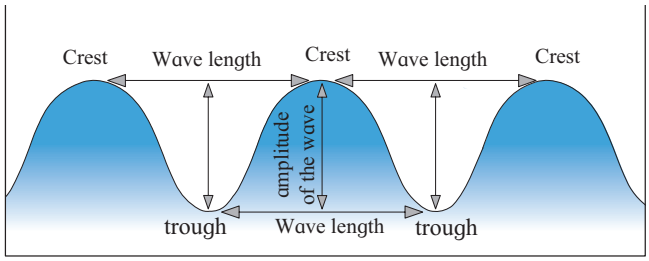


Figure 3.11 : The structure of a wave

Velocity of waves:

If we stand at the coast, we feel the waves are coming towards the coast. If a floating object is thrown at a distance in the sea, we find the object moving up and down at the same place. It does not come to the coast. It means the water forming the wave also does not come to the coast. Remember that the water in the wave does not move, what moves is the energy.

The main reason of wave generation is wind, but at times, due to earthquakes or volcanic eruptions occurring below the floor of the sea, waves get generated. Such waves assume a great height in the shallow waters near the coast. These waves are very destructive. They cause huge loss of property and life. These waves are called tsunamis. In 2004, tsunami waves were generated because of the earthquake that took place near Sumatra island of Indonesia. They devastated the east coast of India as well as of Sri Lanka.

The waves cause erosion along the headlands and create beaches in the protected locations in the bays.

Always remember–

If earthquake occurs in the ocean, the coastal areas face a risk of tsunamis. In such cases, it is better to go away from the coasts or towards higher altitudes. This way, loss of life can be avoided.

Look for me elsewhere!

- ☞ Class 6, General Science Energy Resources.
- ☞ Class 9, Geography Interior Movements.
- ☞ Class 6, General Science, Forms of Energy

Do you know?

While moving along the sea coast or playing in the water we must take adequate care regarding the timings of the tides otherwise it can lead to serious accidents. For that we must know the timings of the tides. For this you must know the phase of the moon on the given day. Three-fourth of the phase of the moon is the time of the high tide. For example, suppose you are at the coast on the fourth phase of the moon, then three fourth of the phase is three. It means the high tide will occur at 3 am and 3 pm, and approximately 6 hours from it, that is, 9 am and 9 pm will be the low tide. There may be slight differences according to local conditions. We must collect the information from local people and learn from them about the structure of the coast, its slope, rocky areas as well as the streams near the coast before entering the sea waters for enjoyment.

Tell the timings of the tides occurring on the first and third quarter days of the month.

Figure 3.12 : Beach

Exercises

Q. 1. Prepare a chain by matching the following.

Group A	Group B	Group C
Waves	8th phase of the moon (Quarter)	Objects get thrown towards the outer side.
Centrifugal force	New moon day	Highest high tide occurs on this day.
Gravitational force	Rotation of the earth	These are also generated due to earthquakes and volcanoes.
Spring Tide	The moon, the sun and the earth	The forces of the sun and the moon operate in different directions.
Neap Tide	Wind	Operates in the direction towards the centre of the earth.

Q. 2. Give geographical reasons:

(1) Tides are influenced more by the moon than the sun.

(2) At some places along the coast, the low lying areas turn into lagoons or marshy lands.

(3) Place located on the opposite meridian to the place experiencing high or low tide will also experience high or low tide respectively.

Q. 3. Answer in brief.

(1) If there is high tide at 7 am, find the timings of the next high and low tides on the same day at a given place.

(2) If at Mumbai (73° E meridian), there is high tide at 1.00 pm on Thursday, then on which other meridian will there be high tide too? State with reasons.

(3) Explain the reasons for the generation of waves.

Q. 4. In what way will the following depend on the tides?

(1) Swimming (2) Steering a ship

(3) Fishing (4) Salt pans

(5) Going to coastal areas for trips

Q. 5. Observe fig. 3.8 of neap tide and answer the following questions.

(1) Which phase of the moon does it show ?

(2) What are the relative positions of the moon, the sun and the earth ?

(3) What effect will it have on the tides ?

Q. 6. Differentiate between

(1) High tide and low tide.

(2) Spring tide and neap tide.

Q. 7. Describe the positive and negative effects of tides.

Activities:

(1) Visit the nearest sea coast. From a higher location, observe the waves approaching the coast. See if the approaching waves change their direction. With the help of your teacher find the answer to why this change occurs.

(2) Collect information from the internet about how electricity is generated from waves. Find places where such electricity is being generated.

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