INTERMEDIATE

WATER

Nearly three-fourths of the earth's surface is covered by water. The world's water resources seem enormous. When we use water for our daily activities we do not pause to think that we are using a very precious resource. Water is the most abundant single substance in the biosphere being 1,500,000,000 cubic kilometers in volume.

Water is a compound of great significance.

It is basically made up of one atom of oxygen and two atoms of hydrogen (H2O).

It is a stable compound and takes part in a variety of chemical reactions. It is an universal solvent.

Pure water is

- Colourless
- Odourless
- Tasteless
- Takes the shape of its container
- Boils at 100° C
- Freezes at O° C
- Has the highest specific heat for a liquid
- Has the highest surface tension for a liquid and hence the highest radius of curvature of water meniscus.

Activity

What is water

- Collect water samples from different sources such as a tap, well, pond, stream etc.
- Observe the following
- the smell
- the colour
- big particles floating on it
- Filter the water with the help of a fine cloth and observe whether the cloth has collected dirt or suspended solids.
- Leave the water undisturbed for half an hour and then see if there is any sedimentation.
- Keep a drop of water on a glass slide and observe it under the microscope for micro-organisms.
- Use a litmus paper to test if the water is acidic or alkaline.
- Add some soap powder to a bowl of water and see if it lathers easily. If it does not, it means that the water is hard.
- Heat water in a vessel. With a thermometer, find out the temperature at which it begins to boil. It should boil at 100°0.

Potable or drinking water should be

- colourless
- odourless
- pleasant to taste
- free from disease - causing organisms

Water that does not contain disease - causing germs is known as bacteriologically potable water

SOURCES OF WATER

In nature, water is found in many forms, but its purity varies. The most common natural sources of drinking water are :

fresh water or ground water lakes, rivers, soil, atmosphere, melting snows, polar ice caps, sea water, etc. can be sources for obtaining fresh water.

Activity

Sources of water

- Make models of the sources of water
- Make charts showing the use of the various water sources

At home

- Draw a map of the surrounding area, marking the water sources such as taps, wells, rivers, canals, etc. in your area.
- Find out how the water is brought to the house.
- Observe the surroundings of the water body and record the findings, illustrating them with drawings.

At school

- What is the water source for the school?
- How should a water source be maintained?
- Bring out the relationships between the water sources, their surroundings and the various forms of life depending on them with the help of a chart.

FORMS OF WATER

The many forms in which we find water are liquid, vapour, ice, snow, mist, dew and fog.

Liquid

Water is mostly in the form of liquid.

Ice

Solid ice is frozen water.

Snow

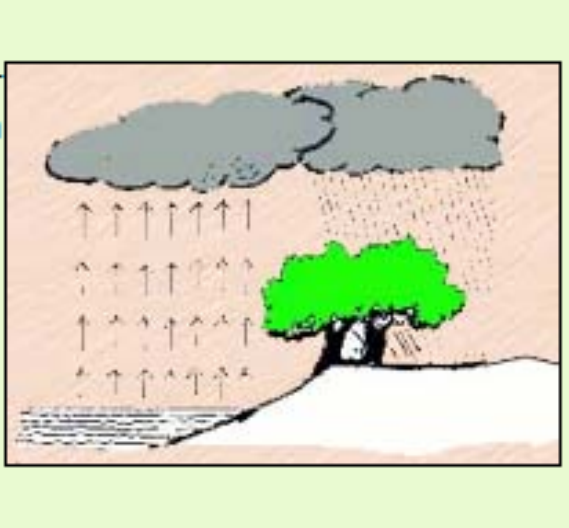
The water vapour in the atmosphere, when cooled, suddenly freezes and collects, forming flakes of snow.

Dew

Water vapour in the atmosphere condenses into droplets to form dew. The droplets of water which appear on leaves early in the morning, after a rainless night, are known as dew.

Vapour & Clouds

Water in its gaseous form is water vapour and is found in the atmosphere. Water vapour is formed from the evaporation of water. The droplets of water vapour form clouds. When the cloud becomes too heavy, the water particles fall down as rain.



Mist

Droplets of water smaller than raindrops are suspended in the air, forming mist.

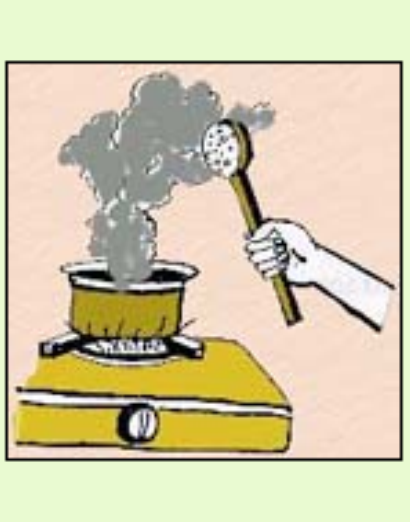
Fog

The thick mist suspended at or near the earth's surface is fog. Fog reduces visibility.

Water is rarely lost, but is constantly put into a cycle where it changes form.

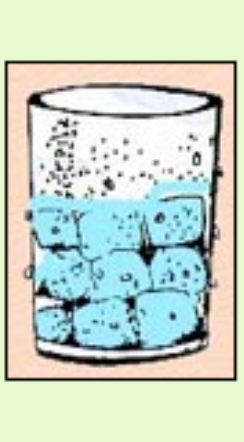
Activity

Evaporation



- Take a vessel and pour a little water into it. Mark the level of water.
- Heat the vessel on a stove.
- As the water boils, watch the water vapour rising from the surface.
- After boiling for a while, the water would have disappeared. The water has now become water vapour which is invisible to the human eye.

Condensation



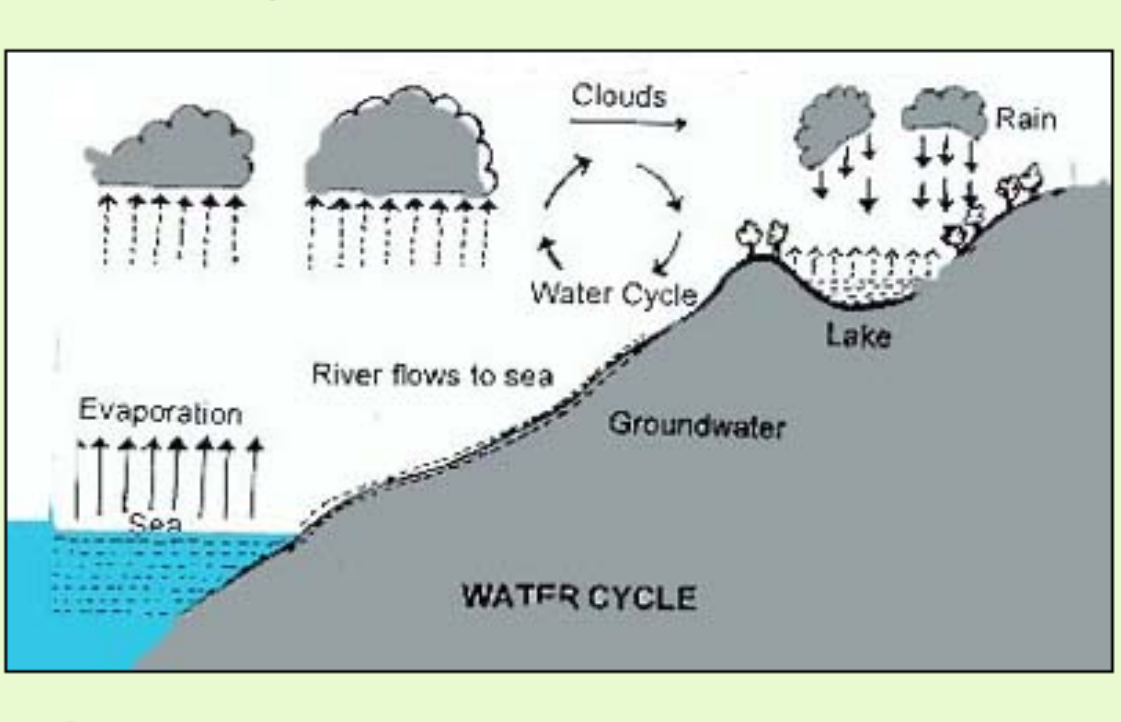
- Collect a few ice cubes in a tumbler.
- Place them on a table and leave them untouched for 10 minutes.
- Observe what happens to the ice and the tumbler.
- As the ice melts, water droplets will form on the outer surface of the tumbler.

These activities reflect the natural evaporation and condensation processes occurring in the Water Cycle.

Make a chart illustrating the experiments on one half and the Water Cycle on the other half.

THE WATER CYCLE

Sea water is salty and cannot be consumed, but it acts as an infinite reservoir for the formation of rain water.



This is how the water cycle works.

- Sea water is heated by sunlight and evaporates from the surface of the sea, thus forming rain-bearing clouds.
- When the clouds are saturated with water, they condense and fall down as rain.
- The rain water forms rivers and lakes, replenishing ground water resources.
- The rivers then empty into the sea and thus the cycle continues.

Rainfall is brought about by

- Monsoon
- Orographic phenomenon or rainfall caused by the presence of mountains
- Cyclones
- Convection

Activity

USES OF WATER

For Drinking

- Each one of us consumes 8 glasses, or roughly 1,600 ml of water per day.

For Generation of Hydro Electric Power

35% of India's power comes from hydel sources.

- Approximately 200 litres of water are required per person per day for washing, bathing, cooking, and cleaning.

For Thermal Power

Water is used as a coolant in thermal power plants and other heat-generating industries.

For Industries

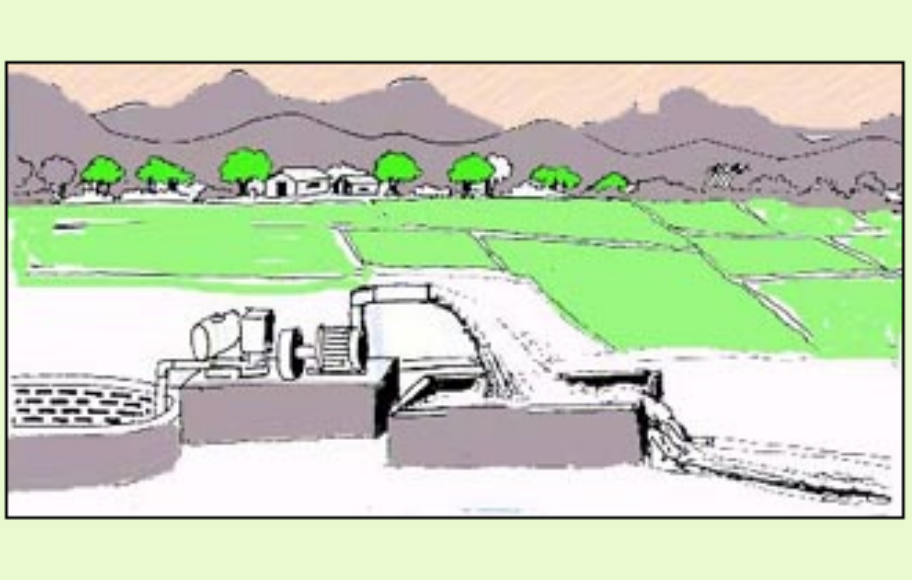
- Paper mills
- Chemical plants
- Textile and dyeing mills
- Cement factories
- Steel plants

These industries use water for their processes.

- 55,000 litres of water are used for the manufacture of 1 tonne of paper.
- 400,000 litres of water are used for the manufacture of 1 tonne of steel.

For Irrigation

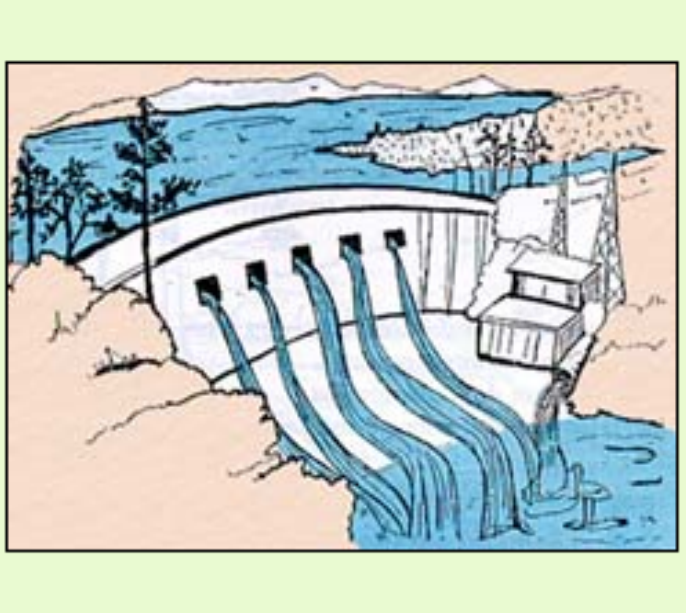
Nearly 90% of India's water resources are used for irrigation.



COLLECTION OF WATER

- Rain water collects naturally in ponds, rivers, streams and springs.
- A part of the water that falls as rain percolates into the ground. When wells are dug, this ground water is made available for our use.
- Dams are physical structures laid across bodies of water. They act as a barrier to restrain the flow of water.
- Ancient dams were earthen, unlike the concrete ones of today.
- Only 42 dams were in existence before this century.
- By 1986 , 256 large dams with an average height of 15 meters and above had been constructed and 154 more were under construction.

Dams help



- to store running water
- to irrigate the land
- to generate hydel energy
- to generate employment during their construction.

But, dams also

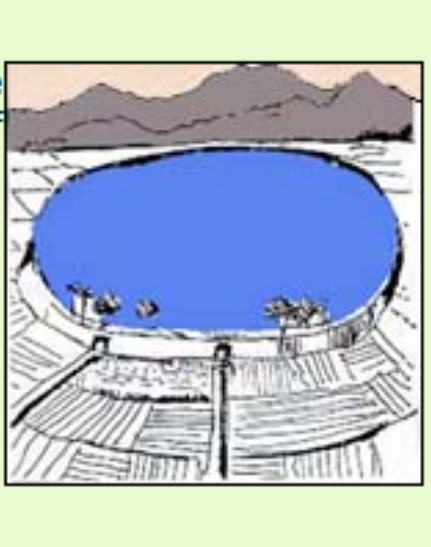
- submerge prime agricultural land, leaving it less productive
- eliminate flora and displace fauna
- make many lands saline and water-logged because of excessive and indiscriminate irrigation
- displace people from their traditional homes.

Facts About Dams

- India's highest dam is the Tehri Dam in Ultra Pradesh, which is 261 meters in height.
- Small earthen dams for water harvesting are both ecologically sound and economically profitable. There will be no soil erosion, deforestation, decertification and displacement of human population. e.g. small reservoirs, check dams, etc.
- Dam disease -- Large reservoirs elevate the level of sub-soil water in the vicinity and change the levels of calcium and trace metals. They also change the fluoride content of ground water.

Yeris

Yeris are man-made earthen reservoirs. Dug in low - lying areas, they collect run off water. The Chengalpet district in Tamil Nadu is named the 'District of Yeris' due to the large number of yeris present there. There are nearly 40,000 yeris in Tamil Nadu.



Tanks

Many parts of India are irrigated by tanks. In Tamil Nadu, for example, yeris are man-made earthen reservoirs dug in low-lying areas which collect run-off water. Kanchipuram district in Tamil Nadu is named the 'district of yeris' due to the large number of tanks present there. There are nearly 40,000 tanks in Tamil Nadu.

Tanks are also man-made water reservoirs with side walls, an earthen floor and steps going down. In the past, it was a practice to construct a tank in front of every temple.

Advantages of natural water resources over dams

Small earthen dams for water harvesting are both ecologically sound and economically profitable because there is NO

- soil erosion
- deforestation
- displacement of human habitations
- silting
- pollution
- wildlife destruction
- cultural destruction
- salinity
- water logging

Advantages of Earthening Reservoirs

Earthen reservoirs can be used to store rainwater, which can be used for irrigation. The region around the earthen reservoir, can be planted with grasses, shrubs and trees, which help to hold the soil in place.

Activity

Measuring rainfall

- This activity may be conducted only during the rainy season.
- Select a perfectly flat site like a playground or open terrace where the rain falls undisturbed.
- Take a cylindrical vessel of known volume.
- Before the rain starts, place the vessel on the selected site and do not disturb it throughout the day.
- At the end of each day, remove the vessel carefully and measure the level of the water collected in the vessels with the help of a scale.
- Draw a graph to illustrate the pattern of rainfall
- How do meteorologists measure and estimate rainfall?
- How is information about rainfall useful to people from different walks of life such as farmers, fishermen, pilots, navigators etc.?
- Which areas in India receive the highest and lowest rainfall?

INDIA'S WATER RESOURCES

- The past ten years have seen droughts in areas as water rich as parts of Kerala. The reason for this has been the persistent deforestation of the Western Ghats.
- Areas like Cherrapunji, which have the world's highest rainfall, have now developed acute water shortage.
- In many parts of India and other developing countries, women and children spend most of their lifetime carrying water from distant sources. With better conservation and distribution, this colossal waste of man-hours can be easily and effectively reduced.
- Excessive deforestation results in silting of the rivers, thereby reducing their water-holding capacity, which in turn, results in the spilling over and flooding of adjacent areas.
- Thick plant cover reduces the amount of run-off water and helps in re-charging the ground water.
- 1,683 million cubic metres of water flow through Indian rivers every year.
- Seventy per cent of all the water available in India is polluted. About 73 million work days are lost due to water-related diseases.
- Human settlements discharge four times as much waste into water bodies as do industries.
- Water-borne diseases such as typhoid, jaundice, cholera, diarrhoea and dysentery account for 66% of all illnesses in India.
- Three-fourths of the total water consumed is used for cleaning and washing and is converted into sewage water. This can be reduced by the economical use of water and diversion of kitchen and bath water for gardening or agriculture. In this way, the summer months are assured of sufficient water.
- Urban families use 6 times as much water as rural families.
- When too much water is drawn from the ground near the coastal region, there are instances of sea water intrusion and many wells have had to be abandoned.

FACTS ABOUT WATER RESOURCES

- 75% of the rainfall is received during the monsoon period (June - October). Tamil Nadu receives rain from the Northeast Monsoon.
- 85 - 90% of the rain water flows into the sea.
- By the year 2000, 40% of the area under crops will be unirrigated.
- If we do not stop constructing dams, there will be hardly any free-flowing rivers left in the country.
- 71% of water is lost from unlined canals, due to seepage.
- Extraordinarily high rate of infant mortality is caused by water-borne infections.
- Fresh water is contaminated with nitrates from chemically supported agriculture.
- Many lakes and reservoirs are becoming eutrophied (enrichment of organic nutrients) and their ability to support aquatic life is being lost.
- Untreated water causes 25,000 deaths a day, in developing countries.
- 1500 million km3 - This is the global water quantity present in our earth !
- Sewage, nutrients, toxic metals and industrial and agricultural chemicals are the main water pollutants
- The main cause of cholera is contamination of water by domestic sewage.
- Mining and other industries are the major sources of contamination of water by metals.
- Industries contribute to acidification of water by release of nitrogen and sulphur oxides into the atmosphere by the burning of fossil fuels.
- Deforestation and destruction of wetland areas are the causes or increased sediment in water.
- Pollution has reduced the annual rainfall from 40,000 km3 to 9000 km3.
- In the hydrological cycle of evaporation and purification, ground water renewal takes 1400 years
- 450 km3 of waste water enter the world's rivers. 6000 km3 of water is needed to transport this waste away and dilute it.
- One fifth of urban population and three quarters of the rural population in developing countries, have no access to safe drinking water.
- In India irrigation accounts for 97% of all water used.
- Put a couple of bricks in the lavatory cistern to reduce its capacity. In the U.S.A. it has been estimated that this amounts to a saving of 3420 litres per household annually.

WATER SCARCITY

India faces acute water scarcity. The causes for which are:

- Wasteful or extravagant use of water.
- Cultivation of hybrid varieties of paddy, wheat, cotton, sugarcane and tobacco which consume more water.
- Evaporation of water stored in large reservoirs and loss by seepage in long canal systems.
- Silting of bodies of water due to denudation of the vegetational cover in the hills and catchment areas.
- Poor ground water resources due to deforestation and overgrazing which result in soil erosion and the inability of the soil to permit percolation of water into the ground.
- Indiscriminate drilling of borewells in areas of water scarcity.
- Subsidised power tariff in the agricultural sector, has resulted in excessive withdrawal of water. This has led to a lowering of the water table which has not been replenished.
- Increased industrial consumption and discharge of raw effluents into the water body have rendered many water sources unfit for human consumption.

Activity

Recharging of ground water

- Take a bucket with a hole in the bottom and plug the hole partially with cotton.
- Pour some water into the bucket and you will see the water dripping out of the bucket.
- Keep pouring water in at the same speed.
- You will see that the water level in the bucket remains unchanged.
- Loosen the plug and let the water flow out of the bucket, but do not increase the speed with which you pour the water into the bucket.
- You will see that the water level starts falling.
- This can be related to the recharging of ground water. Ground water has to be replenished simultaneously as it is drawn out

What are the sources of ground water?

How does the water percolate through the soil?

CONSERVATION OF WATER AT HOME

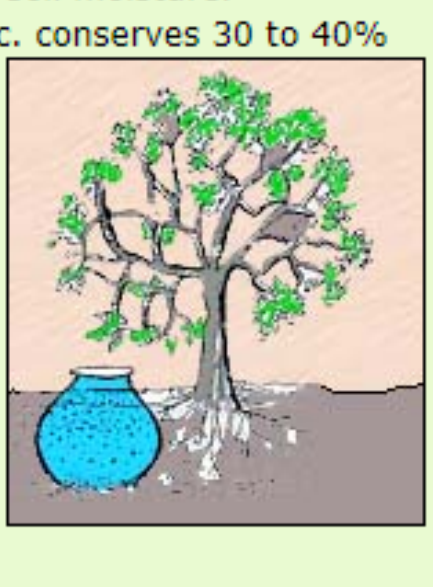
- Water should not be wasted. Leaking taps must be repaired and all taps should be closed when not in use.
- Hand pumps should be well maintained to perform effectively.
- Overhead storage tanks should be maintained in good condition. PVC tanks which are cheaper and lighter in weight and which will not corrode or rust are preferable to metal tanks.
- Rain water can be collected and stored for domestic purposes.

CONSERVATION OF WATER BY THE COMMUNITY

- Canals, tanks, etc. must be desilted regularly during the summer months.
- People should be encouraged to revive the ancient practice of protecting trees around tanks. Major rivers should be sanctified and groves established around villages and on the river banks.
- Afforestation of barren, hilly slopes on a warfooting should be carried out. Trees withstand drought better than crops. They trap dust, replenish streams, provide shade to cattle and man and give fodder for cattle. Their uses to man are innumerable. Denuding the land of trees without compensatory afforestation is a suicidal and short sighted approach to solving immediate needs.
- Creation of small reservoirs and percolation tanks to hold run-off water must be implemented and maintained well.

CONSERVATION OF WATER BY FARMERS

- Agronomic practices like off-season tillage (prior to pre-monsoon showers) conserve soil moisture. Moisture penetration to a depth of 90 cm is achieved if the land is ploughed to a depth of 30 cm. Other practices like early sowing of seeds, moderate use of fertilisers, weeding, pest and disease control and timely harvesting increase the yield inspite of limited moisture in the soil.
- Mulching the soil with organic residue conserves soil moisture.
- Terrace cultivation of hilly slopes prevents water run off.
- Contour ploughing and planting of grasses and trees check run-off water and increase the soil's capacity to retain moisture.
- Green manuring (incorporation of fresh green leaves into the soil) and crop-rotation (cultivating different crops in rotation depending upon the soil and climate, e.g. cereals followed by legumes) conserve soil moisture.
- The use of sprinkler irrigation for closely spaced crops like millets, pulses, groundnuts, etc. conserves 30 to 40% of the surface water.
- Drip irrigation is most suited for closely spaced row crops like vegetables, cotton, sugarcane. The efficiency of this system is around 25 to 30% in conserving soil moisture. The cheapest and easiest form of drip irrigation is to drill one to three holes in a mud pot and bury it partially in the soil next to the plant. The water in the pot drips slowly, ensuring that the soil is continuously moist and the plant gets a constant supply of water.
- Harvesting rain water and storing it in small ponds ensures water supply during summer.
- All these practices are useful only if utilised properly.



IMPORTANCE OF VEGETATIVE COVER IN WATER CONSERVATION

Forests influence the hydrological cycle by

- Interrupting rainfall and allowing it to evaporate back into the atmosphere
- Transpiring large quantities of soil moisture and keeping the soil dry
- Reducing evaporation from the soil by the canopy shape
- Creating soil conditions that allow greater infiltration of water into the ground
- Reducing peak water flow during rainstorms

Activity

Vegetative Cover and Water Conservation

- Collect dry soil in 2 plates
- Pour enough water in each plate to wet the soil.
- Now, place one plate under the shadow of a tree and the other plate in the sunlight
- Leave both the plates undisturbed until evening
- At the end of the day observe the plates.You will see that the soil in the plate kept under the tree is still wet. But the soil in the plate which was kept in the sunlight is dry.

WATER POLLUTION

In developing countries like India, water pollution is due to both the lack of development and industrialisation. Due to poor sanitation, many of our water sources have become cesspools. With the advent of modern agricultural practices and industrial development, the pollution of water sources has greatly increased.

Here are some ways in which bodies of water get polluted

- Discharge of untreated domestic sewage into waterways
- Discharge of industrial effluents
- Discharge of agricultural wastes into waterways
- Use of pesticides, herbicides, fungicides and weedicides which seep into the ground water
- Discharge of fertilizer residues as run-off from farmlands into waterways
- Accidental spillage of oil in the seas by tankers

Control of Water Pollution

- Legislation should be enforced to control water pollution.
- Effluents from industries should be treated and then discharged into water bodies.
- Treated effluents can be recycled for other uses like agriculture and the sludge after drying can be used as manure.
- Many more sewage treatment plants must be installed. At present, raw sewage is discharged directly into water bodies.

Do you know?

- The pollutants in water that are a threat to human health are
  - Sewage
  - Nutrients
  - Toxic metals
  - Chemicals used in industry and agriculture
- Salinity is a significant and widespread form of freshwater pollution, particularly in arid, semi-arid and some coastal regions.
- The most widespread pollutant in water is faecal matter present in sewage, which causes high level of pathogens in water supplies.
- High level of faecal coliforms are found in two-thirds of rivers, in developing countries.
- Water contaminated with faecal coliforms is treated by
  - waste treatment plant
  - disinfecting public water supplies
- Accidental pollution is likely to become serious and frequent as more industries are situated on river banks resulting in long distance transport by water of solid and liquid wastes generated.
- The lack of regulations governing how such industries operate and dispose of their waste is cause for concern, since natural hydrochemical cycles are affected and this in turn affects natural resources.

Activity

Pollution

- Place a transparent vessel on a table and fill it with clean water.
- Ask every one around to drop some rubbish, like a piece of paper, leaf, mud, etc., into the vessel.
- Compare it with a polluted water body.
- Remember that everyone has a responsibility towards keeping our water bodies clean.
- What are the various sources of pollution and how do they affect the ecosystem?

Testing water for dissolved solids

- Take a few drops of water on a glass slide.
- Hold the glass slide over the flame of a spirit lamp until the water has evaporated.
- Inspect the slide for any solid particles left over.
- These particles would have been in the original few drops of water.

Activity

Testing water for turbidity

- Take a 8-10 cm long glass tube of 3 cm diameter
- Fix a length of graph paper on one side with the help of a tape or rubber band.
- Mark a cross on the base of the tube.
- Pour water into the tube and mark the level where the cross becomes invisible on looking into the tube.
- Collect water from different places and repeat the procedure.
- Note the level in each case and compare.
- Higher the level, lower the turbidity.

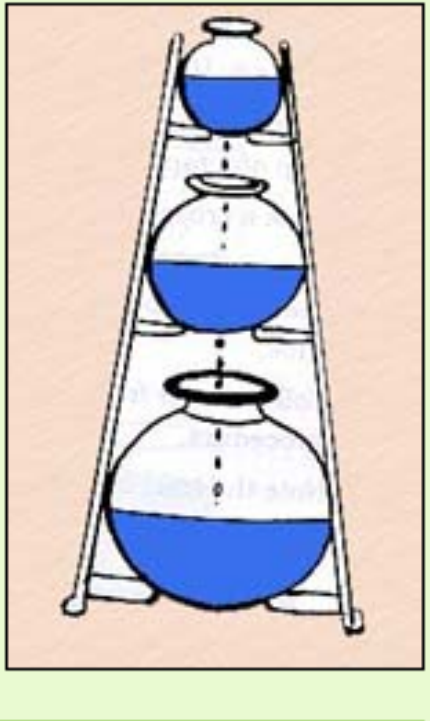
Measuring water pollution by recording indicator species

- Pour some turbid water into a bowl.
- Add clean water and mix properly. Pour this through a filter paper.
- Transfer the residue from the filter paper to a white tray.
- Use a lens to observe the organisms.
- The species found in the water will vary, depending on the extent of the pollution.

Indicator species	Extent of pollution
trout, mayflynymphs, sludge warm(tublex)	No pollutants
rate tailed maggot, cadisfly larvae, blood warm(chironomous),	moderately polluted
water louse, faecal coliform bacteria	Heavily polluted.

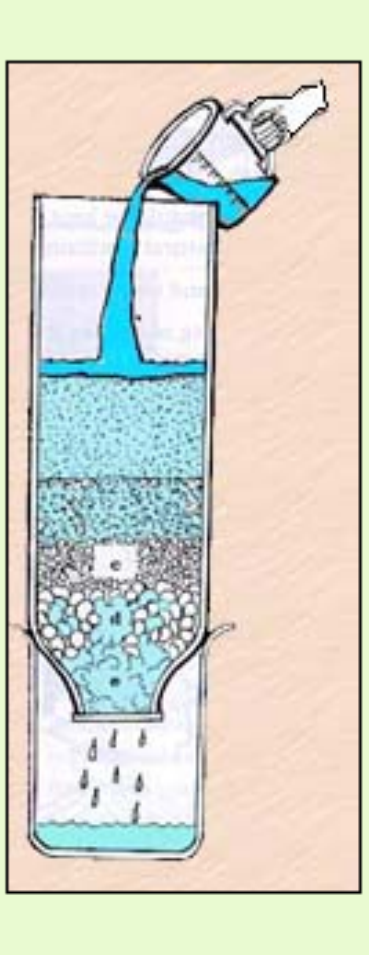
WATER PURIFICATION AT HOME

- The vessels which store water should be clean.
- Rusted, oily, greasy vessels should not be used for storing water.
- Water must be filtered through a clean, white cloth before storing.
- The traditional 3-pot filter can be used for purifying water.
- Water must always be boiled before drinking.
- Modern water filtering equipment capable of removing bacteria can also be used.



Activity

To make a simple water filtering system



- Take a transparent plastic bottle and cut out the base as shown in the figure.
- Fill the bottle witd 5 cm. of each of the following in the order as shown
- Fine sand
- Coarse sand
- Fine gravel
- Coarse gravel
- Cotton
- Pour some muddy water into the bottle and collect the filtered water and observe.
- Discuss the filtering effect of the soil.

This can be made on a larger scale in each home.

WATER PURIFICATION BY THE COMMUNITY

- The surroundings of water bodies should be kept clean.
- Care should be taken to prevent the disposal of domestic or industrial waste into bodies of water.
- Proliferation of Eichornea (water hyacinth), Pistia and algal bloom on water must be prevented.
- Fish should be introduced into bodies of water to purify the water.
- Wells should be kept open to allow fresh air and sunlight to act as a natural sterilizing agent on the surface of the water.
- Wells and tanks must be desilted regularly.
- Washing of clothes and vessels, cattle and automobiles should be prohibited at public tanks, yeris, etc.

WATER PURIFICATION BY INDUSTRIES

Effluents must be recycled and effluent treatment plants must be installed. Each large factory should have its own water treatment plant and small factories should contribute to a cooperative plant. Water pollution by industrial effluents must be treated at the site before the effluents are released into the water body.

The Government should heavily penalise industries if they pollute fresh water and should supervise and inspect industrial effluent treatment plants to ensure proper detoxification and recycling measures.