PROTECTORS OF THE ENVIRONMENT

An CSR Initiative

ONGC TERI Biotech Limited

Build a Sustainable Environment

Module on Energy, Water and Waste

This book is supported by ONGC TERI Biotech Limited (OTBL)

Content Development and Review
Livleen Kahlon, Taru Mehta, Ragini Kumar, Neha, Monmi Barua, Nandita Bardwaj, Sangeeta Paul, Sonali Paikaray

Editorial, Design and Production
Anupama Jauhry, Jessica Mosahari, Anushree Sharma, Santosh Gautam, Vijay Nipane, Aman Sachdeva

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Foreword by Shri Ajay Kumar Dwivedi

Energy, Water, and Waste are three power words that seem to be in vogue. However, on a deeper evaluation of these words, we realize that these are things on which life on earth depends. Understanding the dependency of life on energy and water is comprehensible, but how is waste related to the other two?

“Energy cannot be created nor destroyed; it can only be transformed from one form to another” — Albert Einstein. Every activity that we do on earth requires energy; burning energy in our bodies to do some work, electricity, transportation just to name a few. Optimal use of energy is directly proportional to the economic growth of a country. India’s exploding energy needs can only be catered to if the population supports conservation and sustainable living.

Water is the elixir on what life on earth depends. The rapid growth in population of the globe from 5.7 billion to 7.4 billion in only a decade has been exerting tremendous pressure on the 2.5 per cent freshwater. It is fascinating how this small percentage out of the available 70 per cent of water on earth is fulfilling the requirement of humans. However, the quality of potable water has deteriorated and the availability has become scare. This grim situation can be tackled through strategic water management. Integrated Urban Water Management (IUWM) is one of the initiatives that seem to be a step towards efficient water management.

Manufacturing a pair of jeans uses 10,850Ltrs. of water, a sheet of paper 10 Ltrs., and 1 Ltr. of bottled water 5 Ltrs., — this means wasting any of these products leads to the waste of other resources. What alternatives do we have then? It would be too naive to think that we can stop wastage altogether. We should definitely avoid wastage but also look at effective waste management. Wastewater, for example, is a renewable resource. This resource is abundant with thermal, chemical, and hydraulic energy. Fuel cell power plants convert municipal waste challenges into ultra-clean energy solutions. This is one way using waste productively.

I hope this module will keep the young minds engaged and increase their curiosity to find out ways and help build a sustainable environment.

Ajay Kumar Dwivedi
Chairman
ONGC TERI Biotech Limited (OTBL)

Foreword by Shri (Dr) Banwari Lal

The world faces urgent environmental challenges.

If we are to protect, preserve and sustain our planet, every single individual needs to take positive action on several fronts such as efficient use of energy and water, reduction in waste generation, and conservation of natural resources. It is very important and also rewarding, the actions we take to educate our children on the importance of being a protector of the environment.

Therefore, OTBL initiates this programme “Protectors of the Environment” to reach out to the citizens of tomorrow.

OTBL envisages to weave the environmental message not just into the schools’ curriculum but into every aspect of day-to-day life. By offering training, guidance, learning materials and practical assistance to the students and the teachers, it encourages schools to make a real commitment and measurable progress in reducing energy consumption, raising environmental awareness and inculcating the best practices to last a lifetime.

This book covers the crucial details on energy, water and waste issues and informs the best means to tackle them. The book also engages the students to undertake practical measures to prevent the adversities we see in these areas.

I hope the students are inspired will find their experiences, their projects and their learnings; and further inspire us all with their enthusiastic commitment towards environment conservation.

Best wishes,

Shri (Dr.) Banwari Lal
Chief Executive Office (CEO)
ONGC TERI Biotech Limited (OTBL)

પ્રિય વાચકો,

આપણને જ્યારે પ્રશ્નો ગુંચવતા હોય ત્યારે ઈન્ટરનેટની મદદથી તેનું સમાધાન શોધવા પ્રયત્ન કરીએ છીએ અથવા તેના સંબંધિત પુસ્તકમાંથી જવાબ શોધીએ છીએ. આ રીતે આપણને જરૂરી માહિતી મળી જાય છે પણ તે સ્પષ્ટ અને સરળ ન હોવાથી તેનું તારણ કાઢવું મુશ્કેલ બને છે.

વિદ્યાર્થીઓની આ સમસ્યાને ધ્યાનમાં રાખીને અમે આ પુસ્તક 'Build a Sustainable Environment' બનાવ્યું છે. આ પુસ્તકમાં સરળ અને સમજી શકાય તે રીતે સમય ક્રમાનુસાર માહિતીને એક સુત્રતામાં મુકવામાં આવી છે.

આ પુસ્તકમાં દર્શાવેલ સત્યશોધનો, કાર્યો અને નિષ્કર્ષ ફક્ત વિવિધ ધારણાઓને ન સમજાવતા, તેને રોજંદા જીવનની ઘટનાઓ સાથે પણ સાંકળે છે. આ કાર્યો અને નિષ્કર્ષો આપને આપના પર્યાવેશની સમજણ આપી એક જુથમાં રહી સંયુક્ત રીતે કાર્ય કરવાની પણ સમજણ આપે છે.

આ ગ્રહનું ભવિષ્ય આપણા સામાજીક દાયિત્ત્વ અને પર્યાવરણ પ્રત્યેની જવાબદારી અંગેની સભાનતા અને તે જાળવવા માટેની તકેદારી ઉપર નિર્ભર કરે છે. અમને વિશ્વાસ છે કે આ પુસ્તક આપના સાતત્યપૂર્ણ ભવિષ્ય તરફના ખંતીલા પ્રવાસ માટે પથદર્શક બની રહેશે.

પર્યાવરણ રક્ષક ટુકડી.

CONTENTS

ENERGY

ECONOMIZE TODAY, ENERGIZE TOMORROW

Energy is the basis of human life. All activities, conducted through machines or performed by us, are either a transfer or transformation of energy from one form to another. We use energy to work and make all movements. When we eat, our bodies transform the food into energy to do work. When we run or walk or do some work, we 'burn' energy in our bodies. Cars, planes, trains, boats, and machinery also transform energy into work. Work means moving or lifting something, warming or lighting something.

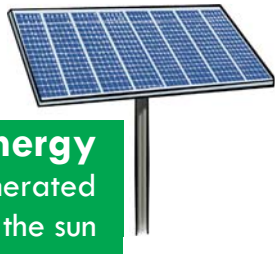
Energy forms an integral part of the vital infrastructure required for economic development and hence, its demand is increasing day by day.
Thus, energy is defined as, 'ability or the capacity to do work'. Let us learn about energy and its sources in this unit.

Sources of energy

Ever since evolution, humans evolved on the Earth, humans are dependent on energy sources like sun, water (hydel), wind, biomass (wood, leaves, etc.) to meet our energy needs, be it sunlight for our daily activities during day time, or burning of wood for cooking and heating purposes.

We can divide sources of energy into two categories—renewable and non-renewable. Renewable sources of energy are those that are inexhaustible, such as the energy from the sun, wind, water, and geothermal.

Non-renewable sources are those that are exhaustible and cannot be quickly replaced, such as fossil fuels and biomass.



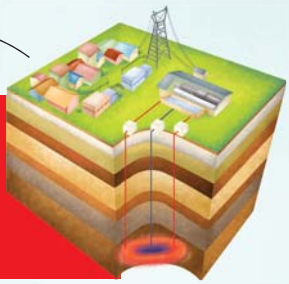
Solar energy
Energy generated from the sun

Hydel power
Energy harnessed from water

Wind power
Energy harnessed from wind

Biomass
Energy generated by the burning of organic materials

Fossil fuels (coal, oil, natural gas)
Energy harnessed from burning of fuels



Geothermal
Energy harnessed from hot dry rocks, magma, hot water springs, etc.

Measuring energy

Heat energy is measured in joules (J) . One joule is the amount of energy exerted when a force of one newton (N) is displaced through a distance of one metre.

Power is measured in joules per second (J/s), which is known as watt (W). Thus, J/s = W and 1000 watt (W) = 1 kilowatt (kW).

Electrical energy is measured in kilowatt hour (kWh).

1 kWh is the electrical energy used or supplied when 1 kW of power is used or supplied for one hour.

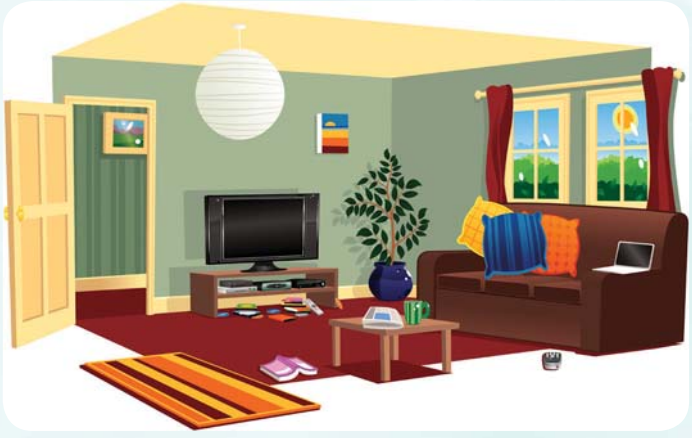
Energy use in various sectors

Energy consumption can be categorized into five mains sectors, namely, residential, commercial, transport, agriculture, and industrial.

Energy consumption in household

In India, household energy is rapidly moving from inefficiently utilized biomass to gas and electricity. This fuel transition is mainly owing to increase in the household income and development of an area. Therefore, this transition has changed people's lifestyle and economic activities.

A common concern is the inefficient use in the residential sector. This wastage is not limited only to the direct usage. For example, when water is wasted, it means the indirect wastage of energy. This is because energy use for pumping water is also wasted.



Energy Bar

A full refrigerator retains cold better than an empty one. If your refrigerator is nearly empty, store water-filled containers in it. The mass of cold items will enable the refrigerator to recover more quickly after the door has been opened.

Let us look at some common wastage areas in homes:

- insulation of electric appliances
- faulty wiring
- over-rated heating or cooling gadgets
- improper fittings and wrong placement of appliances
- negligence in usage/maintenance
- improper ventilation
- unnecessary running of electrical appliances when not required

Commercial sector

This sector consists of all types of workplaces, such as retail stores, government and business offices, restaurants and hotels, and schools and colleges. Here we will only consider schools. Schools consume a lot of energy. During the time spent by students/teachers in schools, they are engaged in different activities. Every corridor, washroom and other public areas require energy to keep them running. This makes it difficult to keep track of energy usage and wastage.

Energy Bar

- Keeping the lights on in an empty classroom overnight wastes enough energy that can make 1,000 cups of coffee/ tea.
- Computers left on overnight waste up to 7.5 watt of electricity per machine.
- A photocopier left on overnight wastes enough energy to print 1,500 A4 copies

Transport sector

The transport sector plays a significant role in the overall development of a nation's economy. But the growing transport demand accompanied by rapid urbanization, increasing vehicular traffic, and heavy dependence on fossil fuels have raised the issue of energy security and environmental quality. This sector includes both light vehicles, such as motorbikes and cars, and heavy vehicles,

such as buses, trucks, etc. Besides the vehicles on roads, other modes of transport, such as trains, ships, and airplanes also form a major part of the transport sector.

Agriculture sector

Agriculture is the dominant sector in the Indian economy. Over a period of time, crop production has emerged as one of the major consumers of commercial energy. This happens in the form of diesel, electricity, fertilizers and pesticides.

The amount of energy consumption has increased manifold over the years due to expansion of irrigation facilities, increased use of fertilizers, and rapid modernization. However, this increase in energy consumption has resulted in high crop yields.

Industrial sector

The industrial sector includes automobile, pharmaceutical, aerospace, mining industries, etc. It is a major energy-consuming sector and uses about 50 per cent of the total commercial energy that is available. Hence, it produces more emissions than any other sector. Today, more recycling and cogeneration technique (which means simultaneous production of electricity and use) have considerably brought down energy consumption in the industrial sector.

Energy Conservation and its efficient use

Rapid industrialization, population growth, commercialization, and changing lifestyles are leading to a sharp increase in energy requirement across the world. This rising demand is resulting in petrol, electricity, cooking gas and fuelwood shortages, in other words, we can say it leads to energy crisis.

The problem of energy crisis can be moderated to a certain extent with the help of cost-effective energy efficiency and energy conservation measures.

Energy efficiency does not mean turning down the thermostat and sacrificing comfort. It means optimum utilization of every energy unit by using state-of-the-art technologies for daily needs for comfortable living and convenient transportation. It is a cheap and clean way to reduce energy use and pollution.

Energy efficiency focusses on change that is technological in nature. The best example is substituting normal light bulbs with energy saving CFLs or LEDs.

Energy conservation is the change in the general behaviour leading to the use of less energy such as turning off lights when leaving a room.

Let's look at various energy conservation measures at home, school and during movement:

At household level

- Ask your parents to set the refrigerator temperature between 2.2°C and 4.4°C.
- Remind your mother to keep the lid on while cooking, and use a pressure cooker whenever possible, as it reduces time and energy usage.
- Next time you see some one ironing clothes, remind them to iron a pile at once, instead of one or two at a time.
- Suggest your parents to replace all incandescent bulbs with CFLs or LEDs. They consume less energy and last longer.
- To protect your house from scorching summer heat, plant a tree so that your house gets natural shade.

Energy Bar

The brightness from a 60 watt incandescent bulb is equivalent to a 14 watt CFL or 10 watt LED.

At school level

- Switch off fans and lights in the classroom when not in use.
- Switch off all gadgets in the laboratory, once the experiments have been performed.
- Do not leave computers and other electrical equipments in the stand-by mode.
- Close water taps properly and get them repaired by your teacher/ helper in school if they are leaking.
- Suggest your school staff to install energy-efficient lighting systems, such as CFLs or LEDs.
- Leave the windows open to use more natural light in classrooms.

While on the move

- Remind your mom/dad to switch off the car engine at red lights.
- Ask grown-ups to avoid stop-start kind of driving as it consumes more energy than driving at a constant speed.
- Use public transport whenever possible.
- Car pooling is a good option. It not only saves money, but also ensures that resources are used efficiently.

Energy Bar

Government of India (Bureau of Energy Efficiency, Ministry of Power) introduced the Standards and Labelling Program in May 2006 for home appliances. Under this program the manufacturers are required to place a label showing how much electricity the appliance will consumer under certain conditions.

More stars means more electricity saving.

ACTIVITY

Make electricity with a magnet

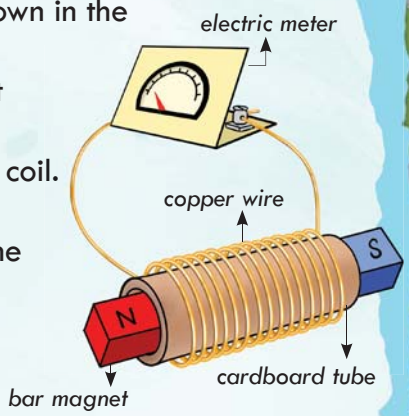
Magnetism is a form of energy. It can push or pull objects. In a similar manner it can also push or pull some of the tiny particles (electrons) that make up matter. And when you push or pull electrons, you get electricity.
Let's try making electricity with a bar magnet.

You Require

• 100 cm of bare copper wire • 1 bar magnet • 1 electric meter
• 1 cardboard tube

STEPS

1. Wrap the wire around the tube about 20 times.
2. Connect both ends of the wire to the meter, as shown in the figure.
3. Take the magnet and move it near the coil but not through it. Observe the meter.
4. Move the magnet in various directions around the coil.
5. Move the magnet back and forth through the coil. Make more than one trial doing this. Try moving the magnet at different pace. Move the coil over the magnet, keeping the magnet still.



Answer the questions given below.

1. In which step did the meter move the most?

_____

2. In what direction were you moving the magnet, when the meter made the greatest movement?

_____

3. Was there a difference between moving the magnet through the coil and moving the coil over the magnet?

_____

4. What did you notice when you moved the magnet at a faster pace?

_____

ACTIVITY

ENERGY SMARTS

The Smart Energy Auditors

Who is a home energy auditor?

A home energy auditor helps people understand when and where electricity is used–or wasted–at home and also suggests ways for energy efficiency.

Who can be a home energy auditor?

Anyone! Home energy audits can be carried out at home to find out parts of the house that use the most energy. Firstly, take a look around your home and list the number of lights and home electronics that use electricity and for how long they are used every day. Then figure out what you can do different every day to save electricity.

Which appliances use the most electricity?

The biggest energy guzzlers are air conditioning units, incandescent light bulbs and old appliances such as refrigerators that aren't Energy Star rated.

How to start your audit?

Find the electricity using appliances in your home and fill the Energy audit sheet on page no.17

According to the NSSO report, titled "Household Consumption of Various Goods and Services in India, 2011-12", in rural areas, household power consumption was 10.7 units per capita per month, while in the urban areas it is 23.6 units per capita per month.

Category	Appliances	Capacity (watt) (a)	Total number of fixture (b)	Number of operating hours (hr) in a day (c)	Consumption in a day[(a x b x c)/1000] (kWhr) (d)	Consumption in a month (dx number of days appliance is used in a month) (e)
Cooling Appliances	Air Conditioner					
	Water Coolers					
	Ceiling Fan					
	Table Fan					
	Pedestal Fan					
	Refrigerator					
Lighting Lamps	Incandescent Bulb					
	Slim Tube					
	Compact Fluorescent Lamp (CFL)					
	Tube Light					
	LED Bulbs					
Heating Appliances	Geyser					
	Electric Oven					
	Iron					
Other Gadgets	Computer/ Laptop					
	Television					
Total units consumed per month						

Just divide column 'e' by the total number of persons living in your house (this is the your monthly per capita power consumption) and check yourself!

Good job, friends! So, now that you have completed the energy audit, suggest some means by which you can reduce the energy consumption in your household. Some suggestions for smart Energy Action Plan are mentioned below:

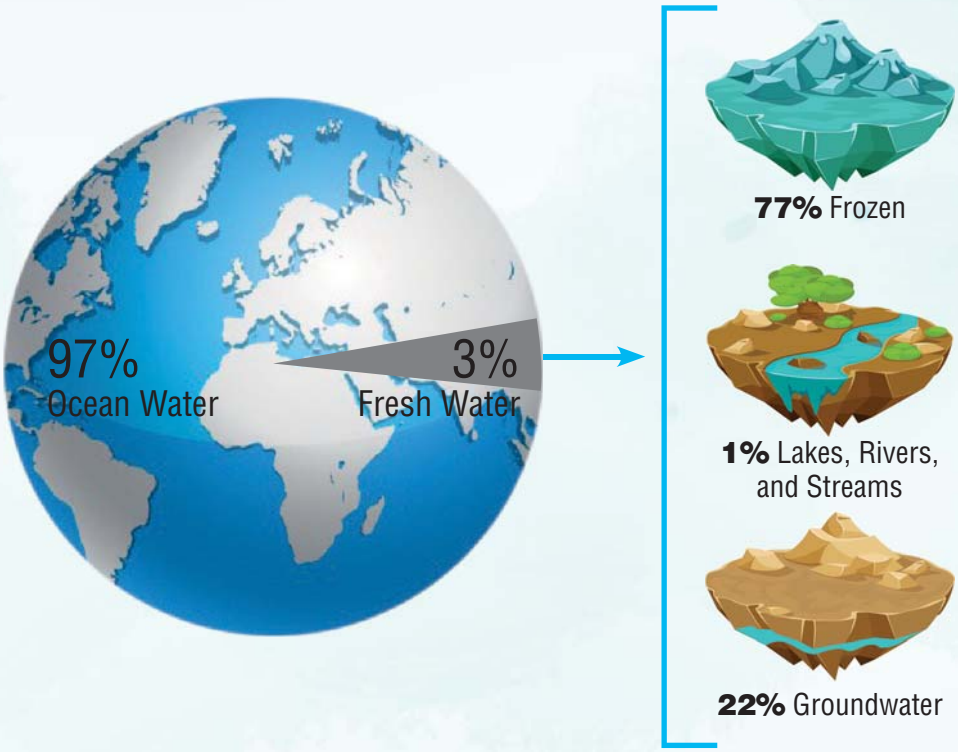
The Smart Energy Action Plan

- ☐ Turn off lights
- ☐ Use energy saving light bulbs
- ☐ Turn off computers and laptops
- ☐ Turn off entertainment devices not in use
- ☐ Unplug your phone charger when not in use
- ☐ Use natural light
- ☐ Use Energy Star appliances

WATER

AN ELIXIR OF LIFE

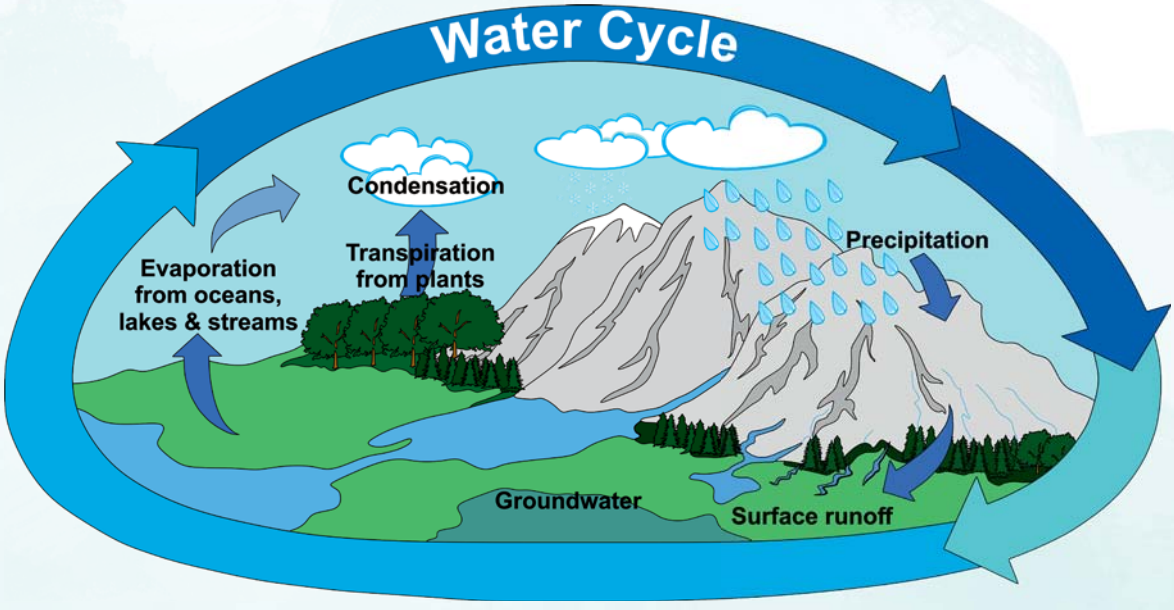
The existence of human beings is impossible without water! We need water in every sphere of our life. If you view from the space, the earth looks mostly blue because 70 per cent of its surface is covered with water. However, 97 per cent of water on earth is undrinkable because it's saltwater. Only 3 per cent of the world's water supply is freshwater. In the available 3 per cent, 77 per cent is frozen and the remaining 23 per cent is not frozen. This 23 per cent caters to the requirement of every plant, animal and person on earth. Coastal regions have so much saltwater that they need freshwater to be piped in from inland areas.



Know about Water

Water is the only substance that occurs naturally as solid (ice), liquid and gas (water vapour). In its purest form, water is odourless, nearly colourless and tasteless.

The water cycle describes how water evaporates from the surface of the earth, rises into the atmosphere, cools and condenses into rain or snow and falls again on the surface as rainfall. The water falling on land collects in



rivers, lakes and soil, with much of it flowing back into the oceans, where the process starts again. The cycling of water in and out of the atmosphere is significant as it influences the weather patterns on earth.

Water Properties

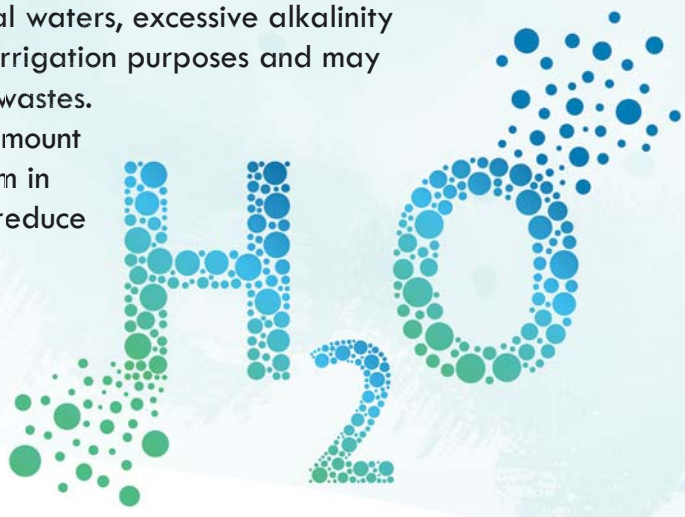
Water is commonly referred to as the universal solvent, as many substances dissolve in water.

pH: It is a measure of how acidic is the water. In other words it is the measure of relative amount of free hydrogen and hydroxyl ions in the water. The range goes from 0 to 14, with 7 being neutral.

Alkalinity: Alkalinity of water is a measurement of its ability to react with strong acids to a designated pH. In natural waters, excessive alkalinity means that water is unsuitable for irrigation purposes and may indicate the presence of industrial wastes.

Hardness: Water hardness is the amount of dissolved calcium and magnesium in the water. High levels of hardness reduce the cleansing power of soap.

Iron: is mostly present in the form of ferrous in both ground and surface water. It does not result in any health aliments; however, its presence can make water bitter.



Residual chlorine: Residual chlorine is the chlorine remaining in water after the chlorination process. Chlorine is a strong oxidizing agent and an excellent biocide, which is used to treat potable waters, municipal wastes and swimming pools.

Importance of Water in our Life

Human bodies have about 60 per cent water. Water regulates body temperature, moves nutrients through our cells and flushes waste from our bodies. When you don't drink enough water, or lose too much water, you become dehydrated. You also need water for your daily activities such as to clean yourself, clothes, dishes and so on. Similarly, plants and animals also require water for their survival. Most of the plants contain 90-95 per cent water and some foods, like watermelon, are nearly 100 per cent water.

Rising Demand of Water

The demand for water has been steadily increasing due to increasing population and pollution has led to a steady decrease in the availability of water that is clean and drinkable. According to World Health Organization (WHO), about 17 per cent of the world's population doesn't have access to clean water. Several government and international organizations, including UNICEF and Water Aid, are working to help poor communities in Asia and Africa to obtain supplies of drinking water and sanitation facilities.

Water Pollution

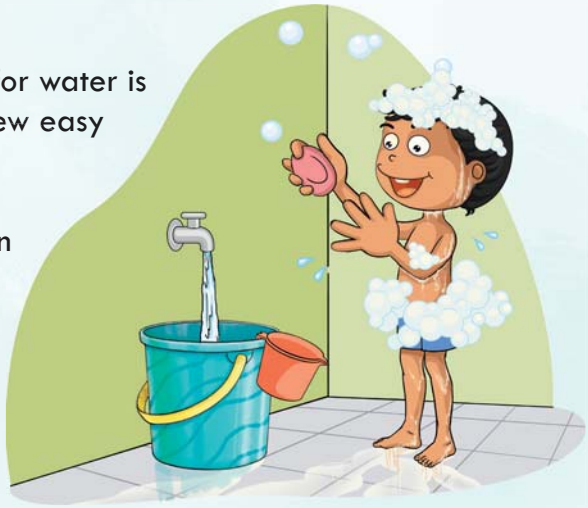
Although we all know how important water is for us to survive, we do not treat this resource in the right manner. Water is polluted by both natural as well as man-made activities. The major causes of water pollution are industrial wastes which contain toxic chemicals and pollutants, sewage and waste water, fertilizers and pesticides in farming, leakage from landfills or sewer lines,

marine dumping and accidental oil spills. All this has leaded to the contamination and depletion of our water bodies.

Contaminated drinking water also causes health issues for human. Typhoid, cholera, dysentery and hepatitis are some common examples of water-borne diseases.

In India, the Water (Prevention and Control of Pollution) Act was implemented in 1974 for the prevention and control of water pollution.

Water Conservation Practices



One way you can help reduce the demand for water is to conserve water year-round. Here are a few easy things that can be done to avoid wastage:

- Turn off water when you brush your teeth. Brushing your teeth with tap turned off can save approximately 6 litres of water per minute.
- Taking shorter showers will reduce water wastage. Water consumption in a single shower is about 6 to 45 litres per minute.
- Run your dishwasher and washing machine only when they're full.
- Reuse rinse water from washing machines for toilet flushing and floor cleaning.
- Install water-efficient taps and showerheads to reduce water usage. Fixing a leaky tap will save 15 litres of water a day, or 5,500 litres of water a year.
- Use dual flush system in the toilet.
- Use rainwater for gardening and car washing.
- Wash fruits and vegetables in a bowl of water instead of running tap water.

Rain Water Harvesting – An easy source of Water

Rainwater harvesting can provide for about 50 per cent of a family's water needs. This will not only save water, but save money and reduce our impact on the environment.

Rainwater harvesting is a process where you accumulate and store rainwater for reuse. Rainwater harvesting can be used to provide drinking water, water for livestock, irrigation

and refilling of ground tanks. This can solve the age-old problem of availability of water on the surface of the earth.

Rainwater can be harvested from the following exteriors-

Rooftops: Rainwater is captured from the roof catchments and stored in reservoirs. The harvested rainwater can be stored in surface groundwater tanks to meet the household needs.

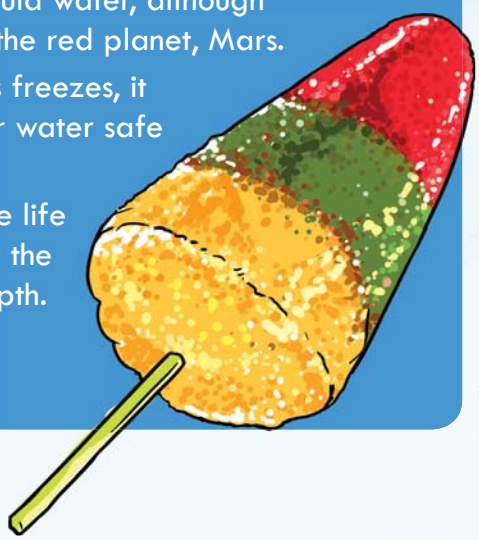
Paved and unpaved areas: Landscapes, open fields, parks, roads and pavements and other open areas can be effectively used to harvest the runoff. The main advantage in using ground as collecting surface is that water can be collected from a larger area. This is particularly advantageous in areas of low rainfall areas.

Water bodies: Lakes, tanks and ponds are a potential source of storing rainwater. This not only meets our daily needs, but also recharges groundwater aquifers.

Storm water drains: Most of the residential colonies have proper network of storm water drains. If maintained neatly, these offer a simple and cost effective means for harvesting rainwater.

Chuski Time

- In September 2015, NASA's Mars Reconnaissance Orbiter (MRO) discovered intermittent traces of liquid water, although salty, trickling down the surface of the red planet, Mars.
- When ice in lakes, ponds and rivers freezes, it floats on top, keeping the fish under water safe from the cold and chill outside.
- More than ninety per cent of marine life in the oceans live in the top zone or the sunlit zone, between 0-600 ft in depth. It is vital to keep this zone free from pollution.



ACTIVITY

ENERGY SMARTS

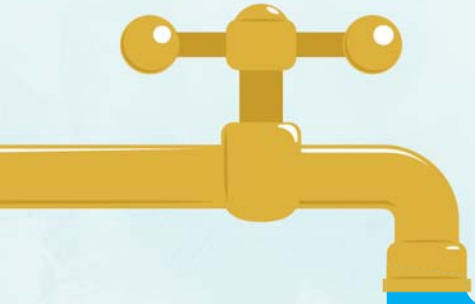
The Smart Water Auditors

The existence of the whole universe is dependent on water. We require water for drinking, making foods, for cleaning our body and other household items, for constructions, paints, etc.

The more we waste water, the more we consume our natural resources like fossil fuels for generating electricity which is required for making clean water.

It is very important for us to make the right use of water and save natural resources, maintain the ecosystem, and avoid harmful calamities like drought, water crisis.

To get an idea of the amount of water your family consumes on an average day, conduct a survey and find out the amount of water being used in your house.



1. Start by asking everyone how many times they did something that needed water.
2. Record the details in the chart.
3. Add the total for all the family members.
4. Calculate the daily total consumption of water in your house.
5. You can now calculate the per month and also per year water consumption in your house.

Usage	Number of times / day	Family Members					Total
	(In Litres)	1	2	3	4	5	
Drinking Water	1 glass is about 0.24 L						
Toilet Flush	• 10 L (full flush) • 6 L (half flush)						
Brushing Teeth (water running)	About 0.0098 ltr (9.84 ml) for 2 min.						
Utensils Washing	An average faucet flows at 7.57 L/min. (number of minutes x 7.57 L)						
Laundry	• Washing machine = (55 L x number of loads) • Buckets = number of buckets x total capacity of the bucket (in litres)						
Shower or Bath	• Shower = 7 L/min. • Bathing using bucket = number of buckets x total capacity of the bucket in litres (a typical household bucket equals 10 L)						
Other Uses (Watering plants, washing car etc.)	• Hose pipe = 9 L/min. • Bucket = total capacity of the bucket						
Total Consumption Per Day							

Water Consumption per month (Grand Total x no. of days/month) =.....

Water Consumption per year (Grand Total x no. of months) =.....

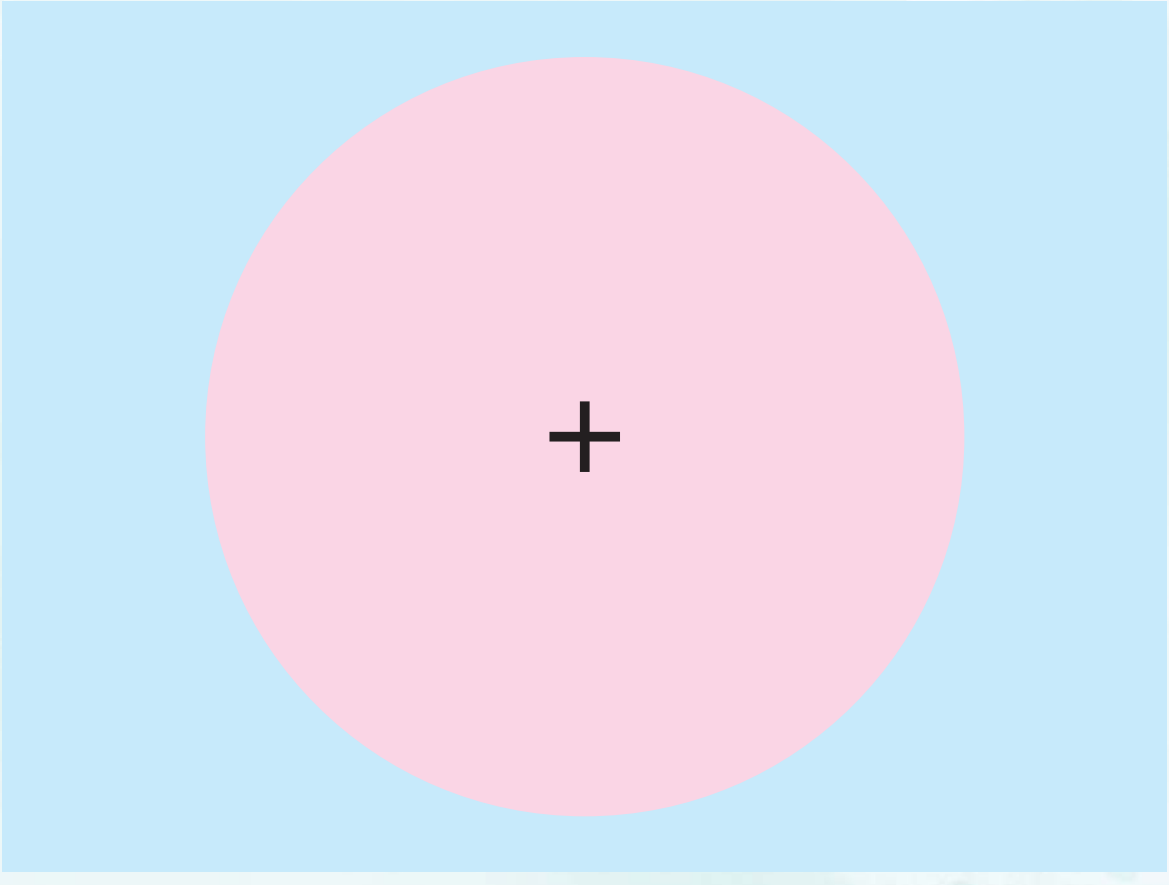
**Use these average figures unless more accurate household-specific data is available.*

ACTIVITY

Charting Your Water Consumption Data

Based on your family's water consumption, determine the percentage breakup for each water usage and place the number in a pie chart (refer to the table in the previous page).

Use different colours to indicate each water-use category. Create a caption around the pie chart, clearly labelling the categories and their percentage.



Now that you know the water consumption pattern of your home, do you think you can reduce water usage? If yes, how?

ACTIVITY

Water Wisdom

There are a number of ways to save water, and they all start with you.
Complete the wordsearch to find the easy ways to save water.

- SHORT SHOWERS
- SAVE RAINWATER
- FIX LEAKS
- REUSE WASTEWATER
- TURN OFF TAPS
- WATERMETER
- USE WATERCAN
- DUAL FLUSH TOILET

T	E	L	I	O	T	H	S	U	L	F	L	A	U	D
W	Q	R	E	R	T	W	Y	I	O	P	A	S	D	F
G	H	E	J	K	L	A	Z	X	C	V	B	S	N	M
Q	W	U	E	T	R	T	T	Y	U	I	O	A	P	A
S	D	S	F	G	U	E	H	J	K	L	Z	V	X	C
V	B	E	S	H	O	R	T	S	H	O	W	E	R	S
N	M	W	Q	L	K	M	N	P	O	I	U	R	Y	T
R	E	A	W	Q	L	E	K	O	J	H	G	A	F	D
S	A	S	S	M	N	T	B	V	F	C	X	I	Z	G
Y	K	T	K	E	H	E	V	P	L	F	O	N	I	K
M	J	E	A	U	Y	R	H	N	B	G	T	W	T	R
F	V	W	E	C	D	E	W	S	X	Z	A	A	Q	L
K	J	A	L	H	G	F	D	S	A	Q	W	T	P	E
R	T	T	X	Y	U	I	O	P	A	S	D	E	F	S
G	H	E	I	J	K	L	Z	X	C	V	B	R	N	M
W	K	R	F	U	S	E	W	A	T	E	R	C	A	N

WASTE
UNTIL IT IS WASTED

Waste is being generated rapidly in great volumes owing to our ever expanding needs and changing lifestyle. It has become a major issue causing harmful impact on our lives and also on the environment. Wastes are generally materials/things which are no longer needed and are discarded or disposed. Wastes are found in solid and liquid forms. Solid forms of waste are plastics, styrofoam containers, bottles, cans, papers, scrap iron and other trash. Liquid forms of waste are water used in homes, chemicals, oils, and waste water from ponds manufacturing industries and other sources.

Waste is broadly classified into bio-degradable, non-biodegradable and hazardous waste.

Biodegradable Waste **Non-biodegradable Waste** **Hazardous Waste**

Biodegradable wastes are food waste, green waste and paper waste which can be decomposed and can be broken down into carbon dioxide, water, methane or organic molecules. Biodegradable waste is used for composting which is manure for soil or naturally decay to produce methane (a form of fuel to generate energy). **Non-biodegradable** wastes cannot be decomposed by microorganisms, air, moisture or soil within a reasonable amount of time. Non-biodegradable waste is an environmental concern as it threatens to cover our entire landfills and with space running out, create disposal problems. It includes items like rubber tires, styrofoam, plastic, fibreglass and metals. As non-biodegradable waste cannot be broken down, recycling is the best option for managing it.

Hazardous waste can be classified as toxic (poisonous waste such as heavy metals, pesticides, etc.); inflammable (waste that is easily combustible or flammable such as solvents, paint wastes, etc.); reactive (waste that may react with water, air or other chemicals such as, waste containing chlorine, cyanides, and so on); and corrosive (waste that dissolves metal, other materials or even burns skin such as acids, caustics, etc.).

Sources of Waste

Municipal waste: This includes household garbage, sanitation residue, construction and demolition debris and waste from streets.

Biomedical waste: Also referred to as hospital waste, biomedical waste includes discarded blood, microbiological cultures and stocks, needles, sharps (razors, scalpels, scissors), human or animal tissue, used bandages, and discarded gloves.

Industrial waste: This includes liquid and solid wastes that are generated while manufacturing and processing units of various materials such as glass, leather, textile, food, and electronics, plastic and metal products.

Electronic waste: It includes discarded electrical and electronic equipment such as computers, TVs, hard drives and pen drives. Due to rapid technological advancements, people are constantly upgrading to latest equipment and discarding the old ones. If old equipment is not recycled properly, the hazardous substances may seep into the air, soil and water, posing a great challenge for human beings.

Agricultural wastes: Wastes generated from farming activities. These substances are mostly biodegradable.

Radioactive wastes: Waste containing radioactive materials, usually byproducts of nuclear processes are radioactive wastes.

Sometimes industries that are not directly involved in nuclear activities may also produce some radioactive wastes, e.g. radio-isotopes, chemical sludge, etc.

A typical electronic product contains more than 1,000 different components, some of which may pose a hazard to humans and the environment.

Impacts of Waste

Waste poses a lot of problem. When it is exposed to the open environment:

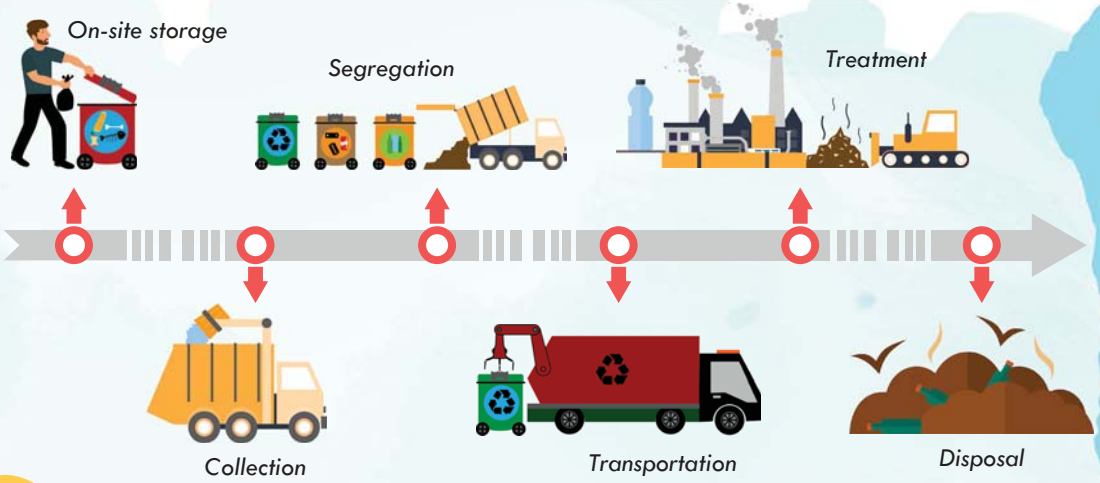
- It is harmful to human health because it attracts rodents, pests, and pathogens.
- It pollutes the soil and groundwater.
- Waste when dumped into water bodies, causes water pollution that leads to water-borne diseases and poses a fatal threat to aquatic life.
- It causes health hazards in animals, especially in the case of cattle and stray dogs that scavenge for leftover food in garbage.
- Waste disposal processes such as landfill and incineration may release toxic gases.
- It also releases greenhouse gases that contribute to global warming. It causes visual pollution and also emits foul smell.

Management of Waste

To reduce the adverse impact of waste on the environment and human health, the best way is to manage waste appropriately or even better reduce it. An effective waste management system involves the processes mentioned below:

1. On-site storage: This is the first step of the waste management process, wherein the generated waste material is stored after segregating the recyclables. It is the responsibility of the waste generator to separate recyclable materials.
2. Collection: This step involves the collection of waste from the point of production such as residential, industrial, commercial or institutional. They are collected through door-to-door collection, community bins, contracted services, etc.
3. Segregation: Segregation of waste is now compulsory, as per Solid Waste (Management and Handling) Rules 2000. Segregation means separation of waste into dry and wet categories, so that it is easier to handle it at a later stage.

4. Transportation: Depending on the physical and chemical properties of waste, it is then transported to either the point of treatment or the point of disposal.
5. Treatment: Waste treatment methods are selected and used based on the form, composition, and quantity of waste materials. This approach has several advantages. It recovers energy for electricity or heating, reduces waste volume, lessens transportation costs and decreases harmful greenhouse gas emissions.
6. Disposal: No matter what treatment is done, there will always be some remainings that needs to be disposed of safely. Landfilling is the most cost-effective way of eliminating solid waste residue after the treatment.



Waste Treatment Techniques

Incineration: This method involves burning of waste material in a controlled manner at high temperature. This treatment method is commonly used as a means of recovering energy for electricity or heating.

Gasification and Pyrolysis: These are two similar methods, both of which decompose organic waste materials by exposing waste to low amounts of oxygen and very high temperature. Pyrolysis uses absolutely no oxygen while gasification allows a very low amount of oxygen in the process. Gasification is more advantageous as it allows the burning process recover energy without causing air pollution.

Landfills: Landfills provide the most commonly used waste disposal solution. These landfills are desired to eliminate or reduce the risk of environmental or public health hazards due to waste disposal. These sites

are situated away from habitation areas, low water table and surface soil which is resistant to hazardous wastes. Recent technological research have introduced Bioreactor landfills which use superior microbiological processes to speed up waste decomposition. The controlling feature is the continuous addition of liquid to sustain optimal moisture for microbial digestion.

Biological Processing or Composting: Waste material that is organic in nature can be recycled through composting and digestion process to decompose the organic matter. Composting is the natural process of 'rotting' or decomposition of organic matter by microorganisms under controlled conditions.

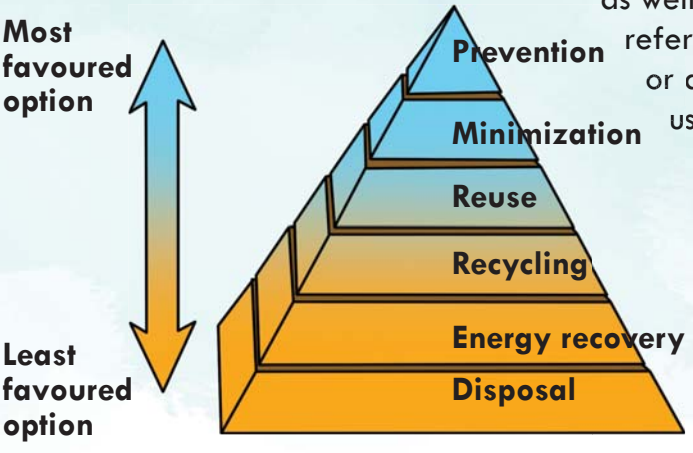
In this process, the kitchen and garden waste (including vegetable and fruit peelings, tea bags, egg shells, dead plants, leaves etc.) is collected in the compost bins. In the presence of air (oxygen), aerobic bacteria act on the waste and cause its decomposition, thereby releasing heat, water vapour, and carbon dioxide. Waste is then turned into compost, which can be used as manure in gardens. Compost is a rich source of organic matter which plays an important role in sustaining soil fertility, and hence in sustainable agricultural production. In addition to being a good source of plant nutrient, it also improves the quality of the soil.

Importance of 3Rs

The 3Rs—reduce, reuse and recycle—are three great ways to reduce or eliminate waste and protect the environment.

Waste and how we choose to handle it affects everything around us, such as the air, water, land, plants, and all man-made things. Since we need a healthy environment for our holistic well-being, effective waste management is essential.

The first R stresses on reducing the amount of waste we usually produce or using less than usual in order to avoid waste. The second R focusses on reusing materials instead of throwing them away or passing these to others who could also use them as well. The third R, that is recycling refers to the process of converting old or discarded products into something useful and beautiful. Such items are collected, reprocessed, and used again for making new products. The 3R policy can protect the environment by saving resources, including energy.



ACTIVITY

Create Your Own Compost Pit

Composting kitchen waste can limit the amount of food you waste and help reduce your impact on landfills. In fact, if you compost on a continual basis, the volume of garbage you generate can be reduced by as much as 25 per cent! Composting is very practical, convenient and fun to set up. Follow this step-by-step list and start your own composting system in your home.

Step One: Your compost bin. Take a composting bin or you can use an old dustbin can, and find a suitable place to keep it.

Step Two: Fill your bin with a balanced mixture (for best results). Compost bins work best with a balanced mixture of green stuff, brown stuff and water.

Green stuff is kitchen wastes which include fruit and vegetable leftovers, green leaves, egg shells, tea bags and so on. They are high nitrogen materials and activate the heating process in your compost.

Brown stuff is garden wastes which are high carbon materials and serves as the "fiber" for your compost. It includes hay, grass, ash, sawdust, wood chips or straw.

Water – Your pile should be about as damp as a sponge that has been squeezed out. Add water if the waste pile looks dry. A lid on the compost bin will help to keep moisture in.

Step Three: Mix the compost.
All you have to do is mix the components once every week or two. This helps accelerate the composting process. Add more layered materials as they become available.

Step Four: Harvest your compost.
When the pile shrinks in size, turns dark and crumbly, it means the compost is ready for use.

Use it in your garden, flower beds or even sprinkle it around your houseplants. You can even package it nicely and give it to friends and neighbours.

Tips and Hints

There are a few things that should NOT be composted for reasons of health, hygiene and the inability to breakdown. Make sure not to compost the following items:
Meat and fat, diseased plants, fish, vegetable oils, poultry, dog and cat feces, bones, weeds with seeds, dairy products, invasive weeds, plastic or synthetic fibers.

Composting is a great way to decrease your food waste, reduce your impact on landfills, and lower your overall carbon footprint. It's also an activity that everyone in the family can enjoy!

ACTIVITY

Waste-Free Lunch Day at School

Is your lunch waste-free?

Much of the trash we generate comes from the packaging on the food we buy. Disposable water bottles, paper napkins, aluminum foils, plastic wrapping form some of this waste.

How to pack waste-free lunch?

Waste-free lunches are packed with zero waste in mind, favouring reusable food and drink containers, washable cutlery and cloth napkins over prepackaged foods, plastic bags, juice boxes and pouches or paper napkins.

Disposable Lunch	Waste-free Lunch
Plastic or paper bags	Durable lunch box or bags
Drink boxes, pop cans, bottled water	Reusable water bottle or thermos
Plastic disposable spoons, forks and knives	Washable cutlery
Paper towels or tissues	Cloth napkin for reuse
Cling wrap, wax paper or styrofoam	Tupperware, and tiffin boxes

Use this worksheet to compare which items in your lunch was reusable, recyclable and compostable during your waste-free lunch days.

Make sure to pack only what you can eat, reuse, recycle, or compost.

Days	Reusable	Recyclables	Compostable
Example	1 plastic container, 1 plastic bag from cookies	1 soda can	1 banana peel
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Total			

Add It Up!

If you have scored high for 'Reusable' and low for 'Recyclables' and 'Compostable', you have reduced the need for disposal, saved energy, and prevented pollution.

See how much waste you would avoid if you packed waste-free every day!

ACTIVITY

ENERGY SMARTS

The Smart Waste Auditors

A waste audit is an analysis of a localized waste stream from your household. You can identify the type of waste that it generates and in what amount. But how do you conduct an audit?

Conducting a waste audit at home enables you to examine what are you disposing of and helps you to come up with plans to eliminate or reduce these amounts. You may conduct these audits every year and compare them to previous years to see the changes.

Things required

- Rubber gloves, masks, apron for self-protection
- Tongs for segregation of waste
- Bucket or garbage bag for segregation of different kinds of waste
- Weighing scale for weighing different types of waste
- Data collection sheet for recording (next page)
- Broom/dust-pan/trash bin for clearing the waste
- Soap/water or disinfectant hand-wipes for cleaning yourself after the task

Steps to follow for conducting a waste audit

- Choose a timeframe for conducting the audit of your entire house for a week.
- Identify the waste streams in your household such as kitchen/garden waste, etc.
- Gather the waste within the scheduled dates and timeframe.
- Segregate the waste in the following categories – organic waste (kitchen or garden waste), recyclable waste items (paper/cardboard, plastic, glass, cloth, and metal), e-waste and other waste (hazardous or sanitary waste such as, batteries, chemicals, diapers etc.)
- Take help of adults while segregating waste, for e.g., you need to be careful while handling sharp or dirty objects.
- Count/weigh your waste. Weigh each category of waste by using a bucket or a garbage bag and a weighing scale.
- Record the data for each day in the given table throughout the week.
- Total the data to get your weekly household waste generation. You will also find the kind and amount of wastes which could be recycled, reused or composted.
- You continue to record the data as long as you want. A 3-4 weeks data is considered to be a good sample.
- Review your results and look for opportunities to reduce and reuse.

Household Waste Audit Project Worksheet

Name of Student: _____

Class:_____Schoool:_____

No. of Members in the Household:_____

Location of Household: _____Town/City:_____

_____

List here the types of wastes that were disposed in your household during the audit period.

Day / Date	Organic waste (kitchen and garden waste) (kg)	Recyclable materials (paper, plastic, glass, cloth, wood, metal etc.) (kg)	E-waste (electronic devices) (kg)	Other waste (hazardous or sanitary waste such as, batteries, chemicals, diapers etc.) (kg)
Day One:				
Day Two:				
Day Three:				
Day Four:				
Day Five:				
Day Six:				
Day Seven:				
Total				
Grand Total (Total Waste Generation per Week)				

Your Findings

Total Waste generated per month (kg) (Grand Total x no. of days month)=_____

Total Waste generated per year (kg) (Grand Total x no. of months)=_____

Reviewing Outcomes

1. What kind of waste was generated the most?

_____

_____

2. How much of the waste did you find from packaging?

_____

_____

3. Can you think of alternatives to replace your packaging wastes?

_____

_____

4. How are the different types of wastes disposed from your household?

_____

_____

5. Do you think the household waste is disposed in a correct manner? If not, how do you want to improve it?

_____

_____

6. How can you reduce the amount of waste you produce each day?

_____

_____

PLANT A TREE, SAVE THE PLANET!

Planting a tree is one of the best ways in which you can make a difference in the environment.

Why Are Trees Important?

Trees and plants cover a third of the earth's surface and support countless species and human lives. Along with providing food and oxygen day also provide additional necessities such as shelter, medicine and tools. They improve air quality, prevent soil erosion and floods, regulate water cycles and help check global warming.

It is evident that trees and plants are the integral part of earth ecosystem and our species probably couldn't live without them. Hence, protecting and planting trees is essential for our existence.

So, you can help not just in planting the sapling, but in nurturing it to life and being responsible for its growth.

So, let's get started

Identify a location – School garden, side of the street, garden or park, anywhere where there's space and light.

Just be careful while selecting the location so that once the tress is fully grown it should not cause any problem to anyone. We don't want someone cutting down the tree in a few years.

Plant the sapling – Dig the soil deep enough to cover the roots of the sapling, plant the sapling and cover with soil.

Time to take care – Plants need water, sunlight, air and good quality soil to grow. So, don't forget to water your plant every day.

Monitoring your plant's growth – Choose a particular day in a week when you will measure the growth of your plant (for eg: every Monday). You can use a scale and record the growth in centimeters in the record sheet.

Record the weather conditions also for each week and cotinue.

Measure your plants at the end of every month.

Click photos – You can click photographs with your plants and send us updates and photos on how your plants are doing!

Record Sheet

What is the measure of your plant on day 1? _____

Weeks	How tall is your plant today?(cm)	How was the weather today?
Week 1		
Week 2		
Week 3		
Week 4		
Week 5		
Week 6		
Week 7		
Week 8		
Week 9		
Week 10		
Week 11		
Week 12		
Week 13		
Week 14		
Week 15		
Week 16		
Week 17		
Week 18		
Week 19		
Week 20		

Months	How tall is your plant today? (approx.. every 4th week) (cm)
Month 1	
Month 2	
Month 3	
Month 4	
Month 5	
Month 6	
Month 7	
Month 8	
Month 9	
Month 10	
Month 11	
Month 12	

How do you know that your plant is healthy?

- Plant grows at its pace; it's not an overnight process.
- Healthy plant grows thick.
- Leaves of a healthy growing plant are dark green in colour.
- If it's a flowering plant, a healthy plant will have lots of brightly coloured flowers.

How do you know that your plant is unhealthy?

- Unhealthy plant have discoloured leaves.
- Leaves of unhealthy plants are curled and diseased.

10 Ways You Can Protect Your Environment

Save Energy – Use energy efficient appliances and turn off the switches when not in use. Think about opting for solar energy.

Recycle – Think before you throw. Follow the 3 R's to conserve natural resources and landfill space.

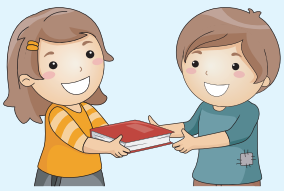
Plant a Tree – Trees provide food and oxygen. They help save energy, clean the air, and help combat climate change.

Avoid Food Waste – Every time food is wasted, the water, energy, time, manpower, land, fertilizer, fuel, packaging and money put into growing, preparing, storing, transporting, cooking the food is wasted.

Save Water – The less water you use and less runoff and wastewater that eventually ends up in the ocean.

Ride a Bicycle or use public transport – This helps to ease congestion, and reduce carbon emissions.

Share or Donate – Give away books, clothes, toys which you do not use anymore to someone who needs them. You will protect the environment, and also contribute to a good cause.



Start Composting – It avoids littering, at the same time being a reliable source of natural manure for your garden.

Educate – Help others understand the importance and value of our natural resources.

Shop Wisely – Buy less plastic and bring a reusable shopping bag.

About the book

This book is an attempt to enhance children's understanding on energy efficiency, water conservation and waste management. It encourages creative thinking in children through engaging activity-based learning and develops competences in environment protection. Children learn more about the environmental issues and its impact on their lives.

The book highlights the importance of making sustainable choices and using alternative forms of energy, thereby reducing the adverse impact on the environment. Further, it enables children to collect, investigate and analyze data to understand energy consumption and carbon footprint. This allows children to design a smart plan for optimal usage of energy and adopt conservation measures.