5 WASTEWATER STORY

THEORY

1.1 INTRODUCTION

All of us use water in our homes and make it dirty.
Rich in lather, mixed with oil, black– brown water that goes down the drains from sinks, showers, toilets, laundries is dirty. It is called **wastewater**. This used water should not be wasted. We must clean it up by removing pollutants.

Clean water is a basic need of human being. Let us make a mindmap of the many uses of clean water. Clean water that is fit for use is unfortunately not available to all. It has been reported that more than one billion of our fellow human beings have no access to safe drinking water. This accounts for a large number of water-related diseases and even deaths. Women and girls walk for several kilometres to collect clean water.

Pollution, industrial development, mismanagement and other factors are responsible for the wastage of water. Realising the urgency of the situation, on the **World Water Day**, on **22 March 2005**, the General Assembly of the United Nations proclaimed the period 2005–2015 as the International Decade for action on **"Water for life"**. All efforts made during this decade aim to reduce by half the number of people who do not have access to safe drinking water.

1.2 SEWAGE

Sewage is correctly the subset of wastewater, that is contaminated with faeces or urine , but is often used to mean only wastewater. Sewage is released by homes, industries, hospitals, offices etc. It also includes rainwater that has run down the street during a storm or heavy rain. Sewage has dissolved and suspended impurities. These impurities are called "contaminants".

Wastewater constituents : Wastewater is a complex mixture containing suspended solids, organic and inorganic impurities, nutrients, saprotrophic and disease causing bacteria and other microbes. A partial list of what it may contain is given below -

(i) **Organic pollutants** : Human faeces, animal waste, oil, urea (urine), pesticides, herbicides, fruit and vegetable waste, etc.

The organic matter of sewage is measured by determining its biological oxygen demand (BOD) or the chemical oxygen demand (COD).
BOD (Biological Oxygen Demand) : It is a measure of the oxygen utilised by microorganisms during oxidation of organic materials.

COD (Chemical Oxygen Demand) : It is an index of the waste (organic and inorganic) of water which can be oxidised by strong oxidising agents.

(ii) **Inorganic pollutants** : Nitrates, Phosphates, metals.

(iii) **Nutrients** : Phosphorus and Nitrogen.
Eutrophication : The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication.

(iv) **Pathogen and micro-pollutants** : **Bacteria** → Which causes cholera and typhoid.
Other microbes → Which causes dysentery

1.3 POTABLE AND NON-POTABLE WATER

Potable water means water which is fit for drinking by humans and other animals. It can be consumed with low risk of immediate or long term harm. Non-potable water is that which is not safe for drinking. It may carry disease causing microbes, and high levels of dissolved salts and minerals, heavy metals and suspended solids. Drinking or using such water for cooking leads to illnesses and may even cause death.

Contaminated or non-potable water can be treated to turn it into potable or drinking water. Let us learn about simple methods of purifying water.

1.4 WASTEWATER TREATMENT PLANTS (WWTP)

Cleaning of water is a process of removing pollutants before it enters a water body or is reused. This process of wastewater treatment is commonly known as "Sewage Treatment". It takes place in several stages.

Treatment of wastewater involves physical, chemical, and biological processes, which remove physical, chemical and biological matter that contaminate the wastewater.

(i) Waste water is passed through bar screens where large objects like rags, sticks, cans, plastic packets, napkins are removed.

(ii) Water then goes to a grit and sand removal tank. The speed of the incoming wastewater is decreased to allow sand, grit and pebbles to settle down.

(iii) The water is then allowed to settle in a large tank which is sloped towards the middle. Solids like faeces settle at the bottom and are removed with a scraper. This is the sludge. A skimmer removes the floatable solids like oil and grease. Water so cleared is called clarified water.
The sludge is transferred to a separate tank where it is decomposed by the anaerobic bacteria. The biogas produced in the process can be used as fuel or can be used to produce electricity.

(iv) Air is pumped into the clarified water to help aerobic bacteria to grow. Bacteria consume human waste, food waste, soaps and other unwanted matter still remaining in clarified water.
After several hours, the suspended microbes settle at the bottom of the tank as activated sludge. The water is then removed from the top. The activated sludge is about 97% water. The water is removed by sand drying beds or machines. Dried sludge is used as manure, returning organic matter and nutrients to the soil.The treated water has a very low level of organic material and suspended matter. It is discharged into a sea, a river or into the ground. Nature cleans it up further. Sometimes it may be necessary to disinfect water with chemicals like chlorine and ozone before releasing it into the distribution system.

1.5 BETTER HOUSE KEEPING PRACTICES

Waste generation is a natural part of human activity. But we can limit the type of waste and quantity of waste produced.

Cooking oil and fats should not be thrown down the drain. They can harden and block the pipes. In an open drain the fats clog the soil pores reducing its effectiveness in filtering water. Throw oil and fats in the dustbin.

Chemicals like paints, solvents, insecticides , motor oil, medicines may kill microbes that help to purify water. So do not throw them down the drain. Used tealeaves, solid food remains, soft toys, cotton, sanitary towels , etc. should also be thrown in the dustbin. These wastes choke the drains. They do not allow free flow of water. This hampers the degradation process.

1.6 SANITATION AND DISEASE

Poor sanitation and contaminated drinking water is the cause of a large number of diseases. A very large fraction of our population defecates in the open, on dry riverbeds, on railway tracks, near fields and many a time directly in water. Untreated human excreta is a health hazard. It may cause water pollution and soil pollution. Both the surface water and groundwater get polluted. Groundwater is a source of water for wells, tubewells, springs and many rivers.It becomes the most common route for water borne diseases like cholera, typhoid, polio, meningitis, hepatitis and dysentery.

(a) **Alternative arrangement for sewage disposal** : To improve sanitation, low cost on-site sewage disposal systems are being encouraged. Examples are septic tanks, chemical toilets, combusting pits. Septic tanks are suitable for places where there is no sewerage system. For example hospitals, isolated buildings or a cluster of 4 to 5 houses.

Some organisations offer hygienic on-site human waste disposal technology. These toilets do not require scavenging. Excreta from the toilet seats flow through covered drains into a biogas plant. The biogas produced is used as a source of energy.

(b) **Sanitation at public places** : In our country fairs are organised periodically. A large number of people participate in them. In the same way railway stations, bus depots , airports , hospitals are very busy places. Thousands of people visit them daily. Large amount of waste is generated here. It must be disposed off properly otherwise epidemics could break out.

The government has laid down certain standards of sanitation but, unfortunately, they are not strictly enforced.

However, all of us can contribute in maintaining sanitation at public places. We should not scatter litter anywhere. If there is no dustbin in sight, we should carry the litter home and throw it in the dustbin.

(c) **Vermi - processing toilet** : A design of a toilet in which humans excreta is treated by earthworms has been tested in India. It has been found to be a novel, low water-use toilet for safe processing of human waste. The operation of the toilet is very simple and hygienic. The human excreta is completely converted to vermi cakes-a resource much needed for soil.

KEY WORDS

1. **Aeration :** Air is pumped to clarified water to help aerobic bacteria to grow.
2. **Aerobic bacteria :** Those bacteria which require oxygen to live are called aerobic bacteria.
3. **Anaerobic bacteria :** Those bacteria which can survive without oxygen are called anaerobic bacteria.
4. **Biogas :** It is a gaseous fuel, which is produced by the fermentation of organic matter.
5. **Contaminants :** The harmful substances which have dissolved and suspended as impurities are called contaminants.
6. **Saintation :** The proper disposal of sewage and garbage from the houses or nearby areas is callled saintation.
7. **Sewage :**Sewage is wastewater released by homes, industries, hospitals, offices and other sewers.
8. **Sewers:** The network of big and small pipes to carry wastewater to treatment plant is called sewers.
9. **Sewerage :** Drainage system of sewers.
10. **Sludge :** Solids like faeces which settle at the bottom of a large tank and are removed with a scraper are called sludge.

CONCEPT APPLICATION LEVEL - I [NCERT Questions]

Q. 1. Fill in the blanks:
(a) Cleaning of water is a process of removing ..... .
(b) Wastewater released by houses is called ..... .
(c) Dried ..... is used as manure.
(d) Drains get blocked by ..... and ..... .
Ans. (a) pollutants (b) sewage (c) sludge (d) cooking oils and fats

Q.2 What is sewage? Explain why it is harmful to discharge untreated sewage into rivers or seas?
Ans. Sewage is wastewater released by homes, industries, hospitals, offices and other users. Sewage is harmful if discharged untreated into rivers or seas because sewage is a complex mixture of suspended solids, organic and inorganic impurities, nutrients, saprotrophic and disease causing bacteria and other microbes.

Q.3 Why should oils and fats not be released in the drain? Explain.
Ans. Oils and fats should not be thrown down the drain. They get hard and block the pipes. In an open drain, the fats clog the soil pores reducing its effectiveness in filtering water.

Q.4 Describe the steps involved in getting clarified water from wastewater.
Ans. **Step 1:** When wastewater passes through bar screens, large objects like rags, sticks, cans, plastic packets are removed.
Step 2: Water then goes to a grit and sand removal tank. The speed of the incoming wastewater is decreased to allow sand, grit and pebbles to settle down.
Step 3: The water is then allowed to settle in a large tank which is sloped towards the middle. Solids like faeces, settle at the bottom and are removed with scraper.
Step 4: Air is pumped into clarified water to help aerobic bacteria to grow. Bacteria consume human waste, food waste, soap and other unwanted matter that still remains in clarified water.
After several hours, the suspended microbes settle at the bottom of the tank as activated sludge. The water is then removed from the top.

Q.5 What is sludge? Explain how it is treated.
Ans. Solids like faeces which settle at the bottom of tank and removed with a scraper is called sludge. The sludge is transferred to a separate tank where it is decomposed by the anaerobic bacteria. The biogas produced in the process can be used as fuel or can be used to produce electricity.

Q.6 Untreated human excreta is a health hazard. Explain.
Ans. Human excreta may cause water pollution and soil pollution. Both the surface water and groundwater get polluted. Groundwater is a source of water for wells, tubewells, springs and many rivers. Thus it becomes the most common route for water borne diseases. They include cholera, typhoid, polio, meningitis, hepatitis and dysentery.

Q.7 Name two chemicals used to disinfect water.
Ans. 1. Chlorine
2. Ozone.

Q.8 Explain the function of bar screens in a wastewater treatment plant.

Ans. When wastewater passes through the bar screens, large objects like rags, sticks, cans, plastic packets, napkins are removed under the filtration process.

Q.9 Explain the relationship between sanitation and disease.

Ans. Sanitation is the hygienic means of promoting health through prevention of hazards of wastes as well as the treatment and proper disposal of sewage wastewater.

Poor sanitation is a major cause of diseases worldwide and improving sanitation is known to have a significant beneficial impact on households and across communities. So poor sanitation and contaminated water is the cause of a large number of diseases.

Q.10 Outline your role as an active citizen in relation to sanitation.

Ans. An active citizen has many responsibilities regarding sanitation. An active citizen should do the following to maintain proper sanitation:

(i) Surroundings should be clean (both inside and outside).

(ii) Sewage system in the home should be properly managed.

(iii) Some leakage or other problem in the sewage system should be reported to the municipality.

(iv) If the sewage of any particular house makes the neighbourhood dirty, we should request them to be more considerate about health of others.

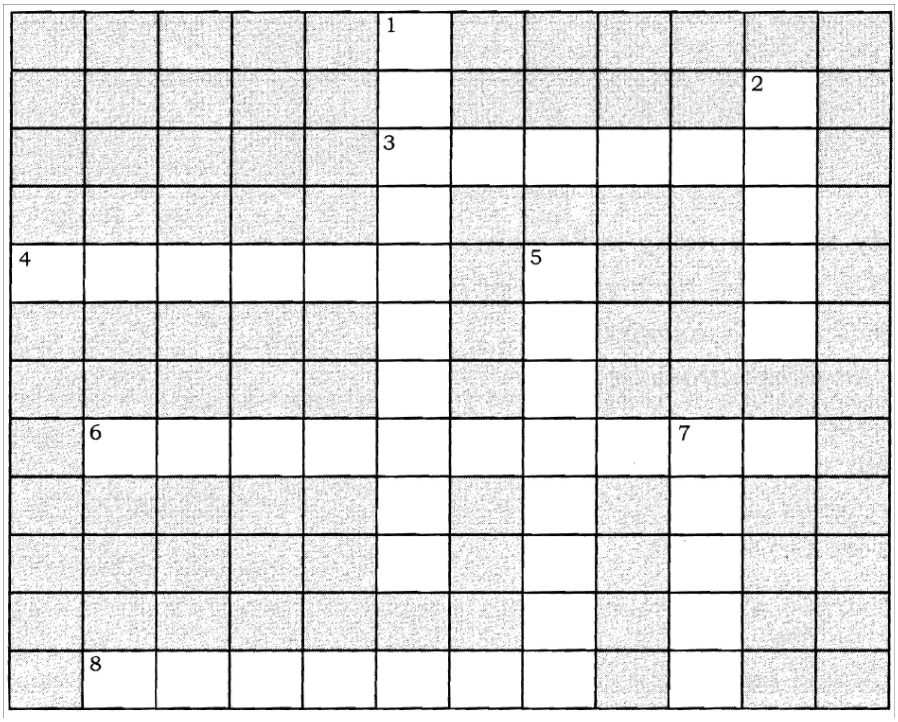
Q.11 Here is a crossword puzzle. Good luck!

Across :

3. Liquid waste products
4. Solid waste extracted in sewage treatment
6. A word related to hygiene
8. Waste matter discharged from human body

Down :

1. Used water
2. A pipe carrying sewage
5. Microorganisms which cause cholera
7. A chemical to disinfect water



Ans. Across :

3. Sewage
4. Sludge 6. Sanitation
8. Excreta

Down :

1. Wastewater 2. Sewer
5. Bacteria
7. Ozone

					1 W						
					A					2 S	
					3 S	E	W	A	G	E	
					T					W	
4 S	L	U	D	G	E		5 B			E	
					W		A			R	
					A		C				
	6 S	A	N	I	T	A	T	I	7 O	N	
					E		E		Z		
					R		R		O		
							I		N		
	8 E	X	C	R	E	T	A		E		

Q.12 Study the following statements about ozone:

(a) It is essential for breathing of living organisms.
(b) It is used to disinfect water.
(c) It absorbs ultraviolet rays.
(d) Its proportion in air is about 3%.

Which of these statements are correct?

(i) (a), (b) and (c)
(ii) (b) and (c)
(iii) (a) and (d)
(iv) All four

Ans. (ii) (b) and (c)

CONCEPT APPLICATION LEVEL - II

VERY SHORT ANSWER TYPE QUESTION :

Q.1 What is the most common substance found on earth?
Ans. Water

Q.2 What is mineral water ?
Ans. Mineral water is water from a mineral spring that contains various minerals, such as salts and sulfur compounds. Mineral water may be effervescent or "sparkling" due to contained gases. Today, it is far more common for mineral water to be bottled at the source for distributed consumption.

Q.3 Which of the day (date) every year is celebrated as the World water day ?
Ans. World Water Day, on 22 March 2005

Q.4 Name the two forms of water found on the surface of water.
Ans. Ice (Solid) and water (Liquid)

Q.5 Name two chemicals used to disinfect water.
Ans. Chlorine and ozone

SHORT ANSWER TYPE QUESTION :

Q.6 What is wastewater? What should we do to waste water?
Ans. Rich in lather, oil mixed, black-brown water that goes down the drains from sinks, showers, toilets, laundries is dirty. It is called wastewater. This used water should not be wasted. We must clean it up by removing pollutants.

Q.7 Is natural water always pure?
Ans. No, most of the natural water is not always pure. Sometimes, it gets polluted due to pollutants present in the environment

Q.8 Which decade is considered as international decade for action on "Water for life"? State its importance.
Ans. 2005-2015.
Since, water is needed for various life activities and many parts in the world are facing shortage of water, it is very important to make people aware about management of water.

Q.9 What is meant by 'Sewage Treatment'?
Ans. Removing pollutants from the waste water, before it enters a water body or is reused, is known as 'Sewage treatment'.

Q.10 Write the organic impurities which are found in sewage.
Ans. Human faeces, animal wastes, oil, urea, pesticides, herbicides, fruits and vegetables.

Q.11 What are the constituents of sewage?
Ans. We know that sewage is a complex mixture containing suspended solids, organic and inorganic impurities, nutrients, saprotrophic and disease causing bacteria and other microbes.

Organic impurities	:	human faeces, animal wastes, oil, urea (urine), pesticides, herbicides, fruit and vegetable wastes, etc.
Inorganic impurities	:	nitrates, phosphates, metals.
Nutrients	:	phosphorus and nitrogen (as minerals).
Bacteria	:	that causes cholera and typhoid.
Other microbes	:	which cause dysentery.

Q.12 What is sewage?

Ans. It is the network of big and small pipes called sewers. It is like a transport system that carries sewage from the point of being produced to the point of disposal, i.e., treatment plant.

Q.13 How much is generally the distance between two nearest manholes in the sewerage?

Ans. Manholes are located at every 50 m to 60 m in the sewerage at the junction of two or more sewage and at points where there is a change in direction.

Q.14 What is the role of the Effluent Treatment Plants in cities?

Ans. The Effluent Treatment Plant filters out undissolved materials from the polluted water/sewage.

Q.15 Describe the process of the treatment of water at waste water treatment plant (WWTP) to obtain clarified water.

Ans. Treatment of wastewater involves physical, chemical and biological processes, which remove physical, chemical and biological matter that contaminates the wastewater.

1. Wastewater is passed through bar screens. Large objects like rags, sticks, cans, plastic packets, napkins are removed.
2. Water then goes to a grit and sand removal tank. The speed of the incoming wastewater is minimised to allow sand, grit and pebbles to settle down.
3. The water is then allowed to settle in a large tank which is sloped towards the middle. Solids like faeces, settle at the bottom and are removed with a scraper. This is the sludge. A skimmer removes the floatable solids like oil and grease. Ultimately the water becomes clear, and called clarified water.

Q.16 List some housekeeping practices to minimise or eliminate waste at their source.

Ans. One of the ways to minimise or eliminate waste and pollutants at their source is to see what you are releasing down the drain.

Q.17 Write the examples of onsite sewage.

Ans. Septic tanks, Chemical toilets, Compost pits.

Q.18 What is vermi-composting toilet?

Ans. A design of a toilet in which humans excreta is treated by earthworms has been tested in India. It has been found to be a novel, low water-use toilet for safe processing of human wastes. The operation of the toilet is very simple and hygienic. The human excreta is completely converted into vermi cakes–a resource, much needed for the soil. This design of toilets is called vermi-composting toilet.

Q.19 How can we contribute to sanitation at public places?

Ans. We all have a role to play in keeping our environment clean and healthy. All of us can contribute in maintaining sanitation at public places. We should not scatter litter anywhere. If there is no dustbin in sight, we should carry the litter home and throw it in the dustbin.

CONCEPT APPLICATION LEVEL - III

SECTION–A

FILL IN THE BLANKS :

(i) .... is generated in homes, industries, agricultural field and in other human activities. This is called ..... .

(ii) Sewage is a liquid waste which causes ..... and ..... pollution .

(iii) Wastewater is treated in ..... treatment plant.

(iv) By products of wastewater treatment are ..... and ..... .

(v) Open drain system is a breeding place for flies, mosquitoes and organisms which cause ..... .

(vi) Dried sludge is used as ..... .

Ans. (i) Wastewater, sewage (ii) water, soil (iii) wastewater/sewage
(iv) sludge, biogas (v) diseases (vi) manures

TRUE (T) OR FALSE (F) :

(i) Wastewater cannot be reused.

(ii) Treatment plants reduce pollutants in wastewater to a level where nature can take care of it.

(iii) Poor sanitation and contaminated drinking water is the cause of a large number of diseases.

(iv) We should not defecate in open because untreated human excreta is a health hazard.

(v) Chemicals like chlorine and ozone are used to disinfect water.

(vi) Cooking oil and fats should not be thrown down the drain because they can harden and block the pipes.

Ans. (i) False (ii) True (iii) True (iv) True (v) True (vi) True

MATCH THE GIVEN COLUMNS :

Column–I	Column–II
(i) Sewage	(a) Decompose sludge
(ii) Bar screens	(b) Used in vermi-processing toilet
(iii) Anaerobic bacteria	(c) Remove large objects from wastewater
(iv) Cooking oil and fats	(d) Disinfect water
(v) Earthworm	(e) Block the pipes
(vi) Chlorine and ozone	(f) Transport system that carries sewage

Ans. (i) f (ii) c (iii) a (iv) e (v) b (vi) d

SECTION–B

MULTIPLE CHOICE QUESTIONS :

Q.1 Which one of the following is a quality of wastewater ?
(A) Foul smell (B) Bad taste (C) Dirty look (D*) All of these

Q.2 Period 2005–2015 is being celebrated as the international decade for action on
(A*) Water for life (B) education for all (C) global warming (D) terrorism

Q.3 In sewerage mainholes are located at every
(A) 20–25 m (B*) 50–60 m (C) 90 – 100 m (D)100 – 110 m

Q.4 Which one of the following is a step in wastewater treatment ?
(A) Aeration (B) Filtration (C) Chlorination (D*) All of these

Q.5 Sludge in separate tanks is decomposed to get biogas by
(A) yeasts (B) aerobic bacteria (C*) anaerobic bacteria (D) non of these

Q.6 Which one of the following is used in vermi-processing toilet ?
(A*) Earthworm (B) Cockroach (C) Both of these (D) None of these

Q.7 Water which is absolutely pure and free from any impurity is known as -
(A) boiled water (B) mineral water
(C*) distilled water (D) None of these

Q.8 Solubility of sugar in water
(A) decrease with increase in temperature (B*) increase with increase in temperature
(C) is not affected by temperature (D) None of these

Q.9 Which of these statements is true ?
(A) Density of ice is more than the density of water .
(B*) Volume of ice is more than the volume of water.
(C) Temperature of ice is more than the temperature of water
(D) None of these

Q.10 Pure water is -
(A) an element (B*) a compound
(C) a mixture (D) None of these

Q.11 Water is called universal solvent because -
(A) it can dissolve all the liquids in the universe
(B) it dissolve all the gases in the universe
(C*) it dissolve large number of solids, liquids and gases
(D) None of these

Q.12 What percentage of water is in our body ?
(A) 30% (B*) 70% (C) 20% (D) None of these

Q.13 Which of these is the surface water ?
(A*) Lakes and rivers (B) Wells
(C) Distilled water (D) None of these

Q.14 The boiling point of water on plains is 100ºC . At hills it will be _____
(A) 100ºC (B) more than 100ºC
(C*) less than 100ºC (D) None of these

Q.15 The purest form of natural water is -
(A*) rain water (B) ground water (C) surface water (D) None of these

Q.16 Solubility of gases in water.
(A) increase with increase in temperature
(B) decreases with decrease in temperature
(C*) decrease with increase in temperature
(D) None of these

Q.17 Water at room temperature is -
(A) solid (B*) liquid (C) gas (D) None of these

Q.18 Water has maximum density at -
(A) 0ºC (B) 10ºC (C*) 4ºC (D) None of these

Q.19 How much of the earth surface is covered with water ?
(A) About 1/3rd (B) About 1/4th (C*) About 3/4th (D) None of these

Q.20 The liquids that dissolve in water are called -
(A) insoluble liquids (B*) miscible liquids
(C) immiscible liquids (D) None of these

Q.21 The ratio of the number of hydrogen atoms and those of oxygen in water is -
(A*) 2 : 1 (B) 1 : (C) 2 : 2 (D) None of these

Q.22 How much water is available for our consumption ?
(A) 0.01% (B*) 1% (C) 10% (D) None of these

Q.23 Which of these has the lowest density ?
(A*) Ice (B) Water at 10ºC
(C) Water at 4ºC (D) None of these

Q.24 The continuous circulation of water in nature is
(A*) hydrological cycle (B) nitrogen cycle
(C) ground water (D) None of these

Q.25 Water is used as coolant in engines because -
(A) it makes us feel cold (B) it freezes easily
(C*) it has a high specific heat (D) None of these

Q.26 We get common salt from -
(A) ground water (B) rain water (C*) sea water (D) None of these

Q.27 Water fit for drinking is -
(A) saline water (B) soft water (C*) potable water (D) None of these

Q.28 The method of watering the roots of plants directly is
(A) surface water harvesting (B*) drip irrigation
(C) water table (D) None of these

Q.29 Water harvesting is done to-
(A*) store water underground (B) store water in fields
(C) distribute water in fields (D) None of these

Q.30 Water that lathers easily with soap is
(A) hard water (B*) soft water (C) saline water (D) None of these

Q.31 The process of removing salt from sea water is called -
(A) chlorination (B*) desalination (C) sedimentation (D) None of these

Q.32 Discharge of wastewater generated from manufacturing plants/industries is -
(A) sewage (B) mining (C*) industrial effluent (D) None of these

Q.33 Primary treatment is also known as -
(A) chemical process (B*) mechanical process
(D) biological process (D) None of these

Q.34 Light floatable water that rises to the top during wastewater treatments is -
(A) sludge (B*) scum (C) Both (A) and (B) (D) None of these

Q.35 In sewage, nitrates and phosphates are -
(A) nutrients (B*) inorganic impurities
(C) organic Impurities (D) None of these

Q.36 The diseases caused by bacteria in polluted water is -
(A) Cholera (B) Typhoid
(C*) Both (A) and (B) (D) None of these