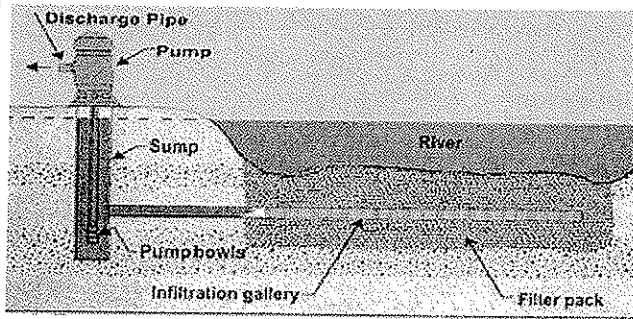


Revision (15) 6012 Course title:Environmental Engineering

Qst. No.	Scoring indicator	Split up score	Sub Total	Total
PART A				
I (1)	Rate of water percolation in the well or yield of a well in m ³ /hr under a head of one metre is called the specific yield (specific capacity) of the well.	2	2	10
I (2)	Slow sand filter, rapid sand filter and pressure filter	2	2	
I (3)	The network of sewers and other devices used in the system of carrying sewage. It deals with the collection and carrying of sewage through underground sewers by water carriage system away from the town and dispose it	2	2	
I (4)	The heavy inorganic materials like sand, ash and others can be removed by using grit chambers.	2	2	
I (5)	1.Disposal on land 2.Disposal in water 3.Direct and indirect reuse of waste water 4.Artificial methods	Any 2- 2 marks	2	
PART B				
II (1)	<ul style="list-style-type: none"> ◦ Safeguards public health by ensuring the quality and quantity of source of water used for drinking. ◦ Less chances of water borne diseases to occur resulting in saving of human lives. ◦ Public gets treated reliable water for consumption and other uses. ◦ Sanitation of the area is considerably improved by the adequate water supply. 	6	6	
II (2)	<ul style="list-style-type: none"> • Infiltration galleries are permeable horizontal or inclined conduits into which water can infiltrate from an overlying or adjacent source. Constructed below the water table in an area where there is sufficient recharge to offset the pumping rate and where the permeability of the soil is sufficient to transmit the quantity of water to the existing gallery under the existing head conditions. • The concept of infiltration gallery is that when water passes through the bed of river which has sand with filter, it is filtered and even when there is negligible surface flow in the river, there is always sub surface flow in the permeable strata of sand below the bed of river, hence we get filtered water continuously. For getting water from infiltration galleries for drinking purpose, perforated pipes will be laid below the river bed at a depth about 5 to 10m from bed level. • These pipes will be connected to a sump-well in which filtered water 	6	6	

will flow under gravity due to head of water about it. This stored water after disinfection will be supplied for drinking purpose.



II (3)

- ❖ The area is divided into different zones.
- ❖ The water is pumped into the distribution reservoir kept in the middle of each zone.
- ❖ The supply pipes are laid rapidly ending towards the periphery.

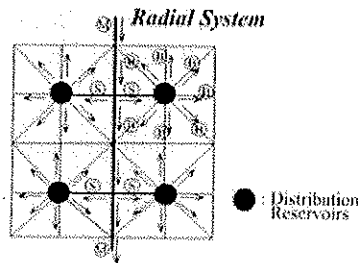


Fig-2
marks

6

Explanati
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marks

Any
5-
30

II (4)

The fine suspended particles like mud particles and the colloidal matter present in water cannot settle down by plain sedimentation with ordinary (lesser) detention periods. Some of the colloidal impurities will not settle even if the water is detained for long periods in the sedimentation tanks as the same charge on the clay particles repel each other and do not allow them to settle down. So the sedimentation is aided with coagulation. Coagulation is a process in which some chemical like alum or ferrous sulphate is mixed in water resulting in particle destabilization. Operationally this is achieved by the addition of appropriate chemical like alum and intense mixing for achieving uniform dispersion of the chemical. These chemicals are more effective when the water is slightly alkaline. Sometimes sodium carbonate or lime is to be added to achieve the suitable pH of water. The process of removal of suspended solids in water by the use of chemical agents is known as coagulation.

6

6

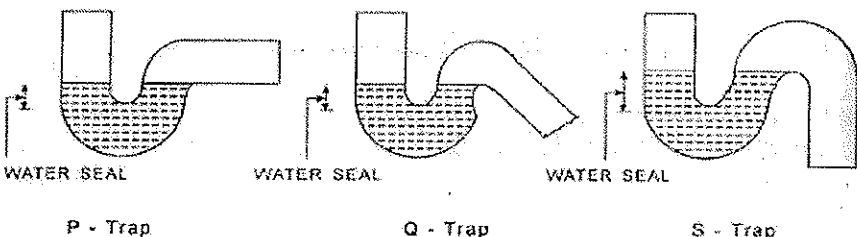
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II (5)

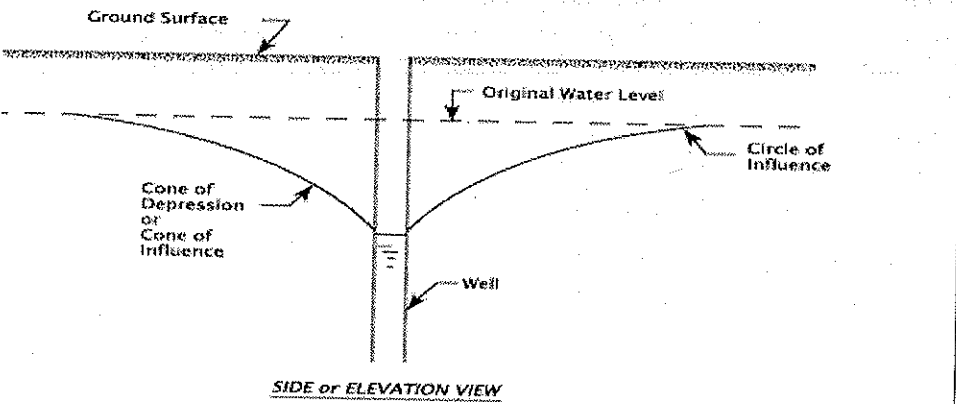
- In this system various types of refuse and storm water are collected, conveyed and disposed of separately by different methods. This method is also called dry system and is in practice from very ancient times. This method is adopted in small towns, villages and undeveloped portions of large city even though it is out of date system.
- In this method garbage or dry refuse is collected from the dustbins and conveyed by trucks or covered carts once or twice in a day.
- All the incombustible portions such as sand, dust, clay, ashes etc. are used for filling low lying areas and combustible portions such as dry leaves, wastepaper, broken furniture etc... are burnt.
- The decaying fruits, vegetables, grass are first dried and then disposed

6

6

	<p>of by burning or in the manufacture of manure.</p> <ul style="list-style-type: none"> • Human excreta or night soil is collected in separate liquid and semi-liquid wastes by animal drawn carts, trucks or tractor trailers and buried in trenches. After 2-3 years the buried night soil is converted into excellent manure which can be used for growing crops. • In this system sullage and storm water are also carried separately in closed or open drains up to the point of disposal, where they are allowed to mix up with streams, rivers or sea. 			
II (6)	<p>Works on the principle of attached growth process. In this process, aerobic bacteria get accumulated on the surfaces of solid medium which are used for oxidize organic matter and flocculate colloidal particles. Trickling filter consist of a circular tank opened to atmosphere. Tank is filled with filter medium consist of broken stones of varying size from 25 to 75mm. Depth of filter medium varies from 2 to 3m. There should be free circulation of air through the medium. Sewage flows through centrally placed riser pipe in which it is distributed through rotary distributors and then to nozzles. When sewage is sent to the distributor nozzles, it will be sprayed on top of filter medium. Sewage then trickles over the surface of broken stone and is finally collected by the under drain system. The active aerobic bacteria present in the film over the surface of broken stones, consume and oxidize the organic matter and finally convert it into stable and settleable form. Oxidized sewage is withdrawn through the outlet at bottom of tank and sent to secondary sedimentation tank for further removal of settleable solids. After continuous operation, the thickness of bacterial layer grows and filter gets clogged. It is necessary for the filter medium to be washed and cleaned at regular intervals.</p>	6	6	
II (7)	<p><u>P – trap</u> The most common of these traps in houses is referred to as a P trap. It is the addition of a 90-degree fitting on the outlet side of a U bend, thereby creating a P-like shape.</p> <p><u>Q – trap</u> Modified S – trap , Reduce siphonage compared to S trap.</p> <p><u>S – trap</u> An S-shaped trap is also known as the S-bend. "S" traps are no longer accepted by the plumbing codes, as these traps tend to easily siphon dry even when well-vented</p> 			

PART C

III (a)	<p>The following are the main factors affecting per capita demand of the city or town.</p> <ul style="list-style-type: none"> ○ Climatic conditions ○ Size of community ○ Living standard of the people ○ Industrial and commercial activities. ○ Pressure in the distribution system ○ System of sanitation ○ Cost of water 	1 mark each point	7	
III (b)	<p>A pump is installed so as to draw sufficient supply of water from open well. In this method water is withdrawn from the well freely till a critical depression head or a safe maximum head is created. That means, first, water level is lowered down by heavy rate pumping till maximum working head is reached. Once this stage is reached the rate of pumping is slowly adjusted so that to maintain the constant water level in the well for a considerable period. Thus, the depression head remains constant. Naturally at this stage the rate at which water is pumped out of the well will be equal to the rate at which water percolates into the well. This rate is expressed in m³/hr or l/min and will be obviously the yield of the well.</p>	2	8	15
		2		
IV (a)	<p>1. Arithmetical Increase Method 2. Geometrical Increase Method 3. Incremental Increase Method</p> <p>1. Arithmetical Increase Method :</p> <p>In this method it is assumed that the population is increasing at constant rate. Rate of change of population with respect to time is constant.</p> <p>Forecasted population (P_n) after n decades from the present is given by,</p> $P_n = P_0 + n.x$ <ul style="list-style-type: none"> • P₀ = Population at present (i.e. last known census) • n = Number of decades between present and future • \bar{x} = Average increase in population of the known decades • Suitable for large and old city with considerable development <p>2. Geometrical Increase Method</p> <p>In this method the percentage increase in population from decade to decade is assumed to remain constant.</p>	<p>Explain any two methods – 6 marks</p> <p>Equations - 2 marks</p>	8	

◦ Also known as “uniform increase method” ◦ Forecasted population (P_n) after n decades from the present is given by,

$$P_n = P_0 \left(1 + \frac{r}{100}\right)^n$$

P₀ = Population at present (i.e. last known census) n = Number of decades between present and future
Assumed growth rate ◦ This method gives the highest value and is best suited for new cities

3. Incremental Increase Method

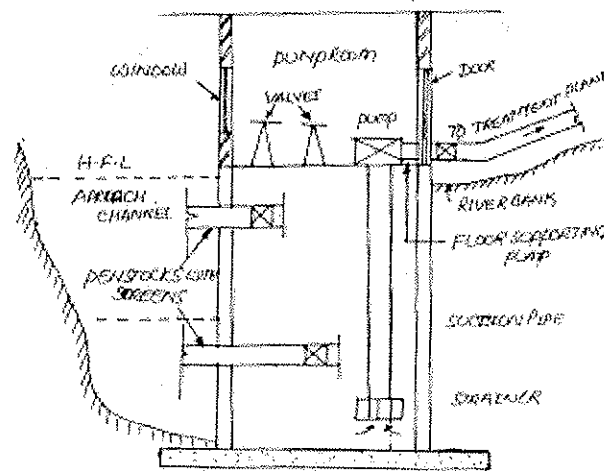
In this method the rate of growth is not assumed as constant. ◦ Also known as ‘Method of Increment’. ◦ Forecasted population (P_n) after n decades from the present is given by

$$P_n = P_0 + n.\bar{x} + \frac{n(n+1)}{2}.\bar{y}$$

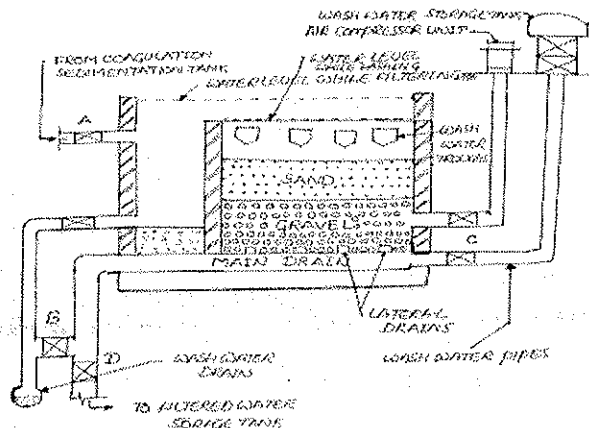
P₀ = Population at present (i.e. last known census) n = Number of decades between present and future
Average increase in population of the known decade \bar{y} = average of incremental increases of the decades. ◦ Suitable for an average size town under normal condition where the growth rate is found to be increasing order

IV (b)

Sl. No.	Test Parameter	IS: 10500-2012 Drinking Water Specification
1.	Odour	Agreeable
2.	Taste	Agreeable
3.	pH value	6.5 – 8.5
4.	Turbidity, NTU, Max	1
5.	Total dissolved solids (TDS), mg/l, Max	500
6.	Total alkalinity as CaCO ₃ , mg/l, Max	200
7.	Total hardness as CaCO ₃ , mg/l, Max	200
10.	Chloride as Cl, mg/l, Max	250
11.	Residual Free Chlorine, mg/l, Min*	0.2
12.	Sulphate as SO ₄ , mg/l, max	200
13.	Nitrate Nitrogen as NO ₃ , mg/l, Max	45
14.	Fluoride as F, mg/l, Max	1.0
18.	E.coli, Presence / Absence	Shall not be detectable in any 100 ml sample

<p>V (a)</p>	<p>Water from the rivers is always drawn from the upstream side, because it is free from the contamination caused by the disposal of sewage in it. It is circular masonry tower of 4 to 7 m in diameter constructed along the bank of the river at such place from where required quantity of water can be obtained even in the dry period. The water enters in the lower portion of the intake known as sump well from penstocks.</p>		<p>Explanati on - 6 Fig - 2</p>	<p>8</p>
<p>V (b)</p>	<p><u>Prechlorination:</u> Addition of chlorine to raw water before treatment is called prechlorination. It helps to reduce load on filter beds. It reduces bacterial load and make water more safe</p> <p><u>Super chlorination:</u> Super chlorination is defined as administration of a dose considerably in excess of that necessary for the adequate bacterial purification of water. About 10 to 15 mg/lit is applied with a contact time of 10 to 30 minutes under the circumstances such as during epidemic breakout water is to be dechlorinated before supply to the distribution system.</p> <p><u>Breakpoint chlorination:</u> It is the addition of chlorine beyond break point from which onwards, any increase in dosage of chlorine will simply appear as free residual chlorine</p>	<p>2 3 2</p>	<p>7</p>	<p>15</p>
<p>VI (a)</p>	<p>Rapid sand filter are replacing the slow sand filters because of high rate of filtration ranging from 100 to 150m³/m²/day and small area of filter required.</p> <p>Rapid sand filter consists of the following five parts</p> <ul style="list-style-type: none"> • Enclosure tank – A water tight tank is constructed either masonry or concrete • Under drainage system – may be perforated pipe system • Base material – gravel should free from clay, dust, silt and vegetable matter. Should be durable, hard, round and strong and depth 40cm. • Filter media of sand – The depth of sand 60 to 75cm • Appurtenances – Air compressors useful for washing of filter and wash water troughs for collection of dirty water after washing of filter. <p>The water from coagulation sedimentation tank enters the filter unit through inlet pipe and uniformly distributed on the whole sand bed. Water</p>	<p>5</p>	<p>7</p>	

after passing through the sand bed is collected through the under drainage system in the filtered water well. The outlet chamber in this filter is also equipped with filter rate controller. In the beginning the loss of head is very small. But as the bed gets clogged, the loss of head increases and the rate of filtration become very low. Therefore the filter bed requires its washing. Washing of filter done by the back flow of water through the sand bed.



2

15

VI (b)

Gravity system

- Suitable when source of supply is at sufficient height
- Most reliable and economical distribution system
- The water head available at the consumer is just minimum required
- The remaining head is consumed in the frictional and other losses

Combined system

- Most common system
- Treated water is pumped and stored in an elevated distribution reservoir
- Then supplies to consumer by action of gravity
- The excess water during low demand periods get stored in reservoir and get supplied during high demand period
- Economical, efficient and reliable system

3 x 2

6

VII (a)

The Sewerage System are classified as follows:

- Combined System
- Separate System
- Partially Separate System

COMBINED SYSTEM:

This system is best suited in areas having small and evenly distributed rainfall, which is distributed, throughout the area, because at such places self-cleaning velocity will be available in every season. As only one sewer is laid in this system, it is best suited for crowded area because of traffic problems. The combined system can also be used in area having less sewage, to obtain the self-cleaning velocity.

SEPERATE SYSTEM:

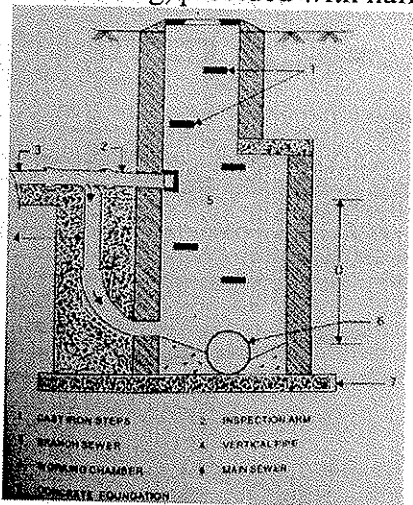
When domestic and industrial sewage are taken in onsets of sewers, whereas storm and surface water are taken in another set of sewers, it is called separate system

1

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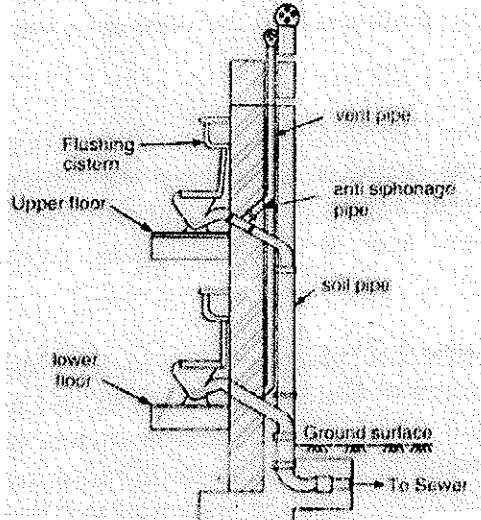
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	<p>PARTIALLY SEPERATE SYSTEM: In the separate system, if a portion of storm water is allowed to enter in the sewers carrying sewage and the remaining storm water flows in separate set of sewers, it is called partially separate system</p>	2		
VII (b)	<p>Drop manhole is constructed when a branch sewer at a higher level is to be joined to main sewer at a lower level. (where the difference in level between inlet level of branch sewer and water line in the main sewer at maximum discharge is greater than 0.6 m). Done by providing a vertical or nearly vertical drop pipe outside the man-hole so that sewage from an inlet sewer at a higher level is dropped through this pipe to the lower level. Other construction details are similar to ordinary man-hole. The drop manhole is also required in the same sewer line in sloping ground, when drop more than 0.6 m is required to control the gradient and to satisfy the maximum velocity i.e., non-scouring velocity. The drop pipe may be outside the shaft and encased in concrete or supported on brackets inside the shaft. If the drop pipe is outside the shaft, a continuation of the sewer should be built through the shaft wall to form an inspection eye and for rodding, provided with half blank flange.</p> 	Fig -2 Explanati on - 6	8	
VIII a.	<p>1. Stoneware sewer The stoneware sewers are also known as the vitrified clay sewers or salt-glazed sewers and they are prepared from various clays and shapes in required proportion, allowed to dry and then burnt in a kiln. A small quantity of salt is added to kiln get glass like glaze on the surface of pipes. ADVANTAGES:</p> <ol style="list-style-type: none"> 1. These pipes are strong enough to take backfilling and traffic 2. The interior surface of sewers are smooth and impervious 3. The overall performance is very good 4. These sewers are cheap and easily available 5. These sewers are durable and better resistance to corrosion & erosion 6. These sewers are capable of withstand hydraulic pressure upto 0.15N/mm² and bear a load of soil of about 4.5 m depth <p>DISADVANTAGES:</p>	Any two- 4 each	8	

	<p>1. These are brittle in nature and may damage in handling or transport. 2. These are not strong enough to allow sewage under pressure. 3. These are difficult to handle or transport because of heavy weight.</p> <p>2. Cast iron sewer The cast sewers possess high strength and they are durable. These are available in sizes from 150mm to 750mm diameter. These sewers can resist the action of acids in sewage if the inner surface is coated with paint or cement concrete. The cast-Iron sewers are used for following special purpose</p> <ol style="list-style-type: none"> 1. Danger of contamination against leakages. 2. Expensive road surface like C.C. can be avoided. 3. Heavy external loads under railway lane, foundation. 4. Under high pressure. 5. The places subjected to considerable differences in temperature. 6. Where the ground is likely to subject to heavy movements and vibrations. 7. Where wet ground required to reduce infiltration <p>DISADVANTAGES</p> <ol style="list-style-type: none"> 1. Cost is high 2. Transportation and handling is difficult <p>3. Cement concrete sewer The cement concrete sewers may be plain or reinforced. The plain cement concrete sewers are used upto the diameter of 600mm and beyond 600mm reinforcement is provided.</p> <p>ADVANTAGES:</p> <ol style="list-style-type: none"> 1. These are strong and impervious. 2. Larger diameter can be made. 3. Inner surface of sewer is smooth. 4. For attack of chemical and erosive actions the inner surface should be lined with vitrified clay. <p>DISADVANTAGES:</p> <ol style="list-style-type: none"> 1. Heavy weight transportation and handling is difficult. 2. Joints should be carefully filled. <p>4. AC Pipe sewers These sewers are made from a mixture of asbestos fibres and cement. They are available upto sizes of 900mm.</p> <p>ADVANTAGES:</p> <ol style="list-style-type: none"> 1. Easy to cut and join. 2. Durable and good resistance to corrosion. 3. The inside surface is smooth. 4. Light in weight and hence easy to handle. <p>DISADVANTAGES:</p> <ol style="list-style-type: none"> 1. Brittle and cannot stand impact forces during handling operations. 2. The structural strength is poor and hence cannot be laid to resist heavy external loads 		
<p>VIII b.</p>	<p>Dry Weather Flow depends on:</p> <ul style="list-style-type: none"> • Rate of water supply • Population 	<p>2</p>	

	<ul style="list-style-type: none"> • Type of area • Infiltration of ground water into sewers • Exfiltration <p>1. RATE OF WATER SUPPLY: The rate of sewage may be 60 to 70 percent of water supply due to various reasons such as consumption, evaporation, use in industries etc. There may be changes daily and seasonally and also depends on the living standards of people.</p> <p>2. POPULATION: As the population increases the quantity of sewage also increases because the consumption of water is more.</p> <p>3. TYPE OF AREA SERVED: The quantity of sewage depends upon the type of area as residential, industrial or commercial. The quantity depends on population if it is residential, type of industry if it is industrial. Commercial and public places can be determined by studying the development of other such places.</p> <p>4. GROUND WATER INFILTRATION: When sewers laid below the water table in the ground, the ground water may percolate in the sewer from the faulty joints and cracks in the pipelines. The quantity of infiltration water in the sewer depends upon the height of the water table about the sewer invert, permeability of soil, size and nature of the faults or cracks in the sewer line. Infiltration generally expressed in litres per kilometer length of sewer per day (l/km/day)</p> <p>5. EXFILTRATION: Leakage of sewage from sewer into surrounding soil. Has to be avoided since it pollutes ground water.</p>	1 mark for explanation of each	7	
IX a	<p>Oxidation ponds are large and shallow; a typical depth would range from 1-2.5m. The ponds are composed of microorganisms, which feed on the organic matter received from primary effluent. Algae are a key feature in the oxidation pond system. Algae are much like the aeration tank in the activated sludge system; they deliver a steady flow of oxygen to the bacteria. The algae require sunlight to produce oxygen via photosynthesis, reaeration created by wind delivers air flow when sunlight is not available. Overall the process is slow and requires large areas of land. Typically oxidation ponds are used in areas with small populations where land is readily available.</p> <p>Advantages: Small energy input Degrades nitrogen and phosphorus</p> <p>Disadvantages: Occupies a large area Possible odours Slow process Long retention times Climate dependent</p>	4 2 2	8	
IX b	Flushing at upper floors creates partial vacuum in the pipe at lower region, inducing syphonic action and thus water seals are sucked in the			

lower floors.
Hence antisiphonage pipes are provided to prevent siphonage action and consequent sucking of water seals.
So that when partial vacuum occurs due to flushing, it may be immediately broken by suction of air from the vent pipe and seals of trap remain intact.

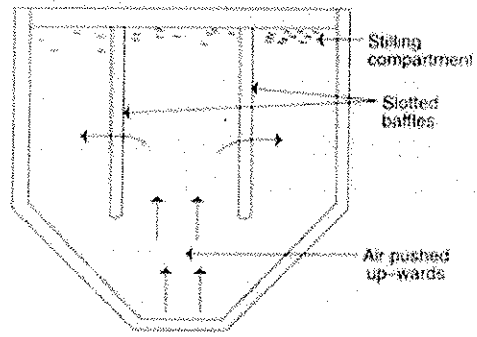


5 7 15

2

X a

- Primary treatment of sewage
- Used for removing fat, oil, grease etc. from sewage.
- The skimming tank is divided into three compartments that are interconnected.
- Compressed air is pushed from the bottom of the tank, the raising air bubbles coagulate and solidify the oily and greasy materials present in the sewage.
- This material is pushed to the side compartment referred to as stilling compartment from where it can be removed manually or mechanically.



5 7

2

X b

- Planning Comprehensive Programme : The State Pollution Control Board is to plan a comprehensive programme for the prevention, control or abatement of pollution of streams and wells in the state and to secure the execution thereof.
- Advisory functions: The State Pollution Control Board is to advise the state government on any matter concerning the prevention, control or abatement of water pollution.

Any 8 8

<ul style="list-style-type: none"> • Dissemination of Information: The State Pollution Control Board is to collect and disseminate information relating to water pollution and the prevention, control or abatement thereof. • Investigation and research: The State Pollution Control Board is to encourage, conduct and participate in investigation and research relating to problems of water pollution and prevention, control or abatement of water pollution. • Organizing training programme: The State Pollution Control Board is to collaborate with the Central Board in organizing the training of persons engaged in programmes relating to prevention, control or abatement of water pollution and to organise mass education programmes relating thereto. • Inspection of sewage/trade effluents plants : The State Pollution Control Board is to inspect sewage or trade effluents works and plants for the treatment of sewage and trade effluents, and to review plans, specifications or other data relating to plants setup for the treatment of water, works for the purification thereof and the system of the disposal of sewage or trade effluents or in connection with the grant of any consent as required by the Water. • Lay down Standards for Causing Discharge of Water : The State Pollution Control Board is to lay down, modify or annul effluents standards for the sewage and trade effluents and for the quality of receiving waters resulting from the discharge of effluents and to classify water of the state. • Economical Methods of Treatment of Sewage : The State Pollution Control Board is to evolve economical and reliable methods of treatment of sewage and trade effluents, having regard to the peculiar conditions of soil, climate and water resources in different regions. 	points	15
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