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SUMMER– 18 EXAMINATION

Subject Name: PUBLIC HEALTH ENGINEERING   Model Answer   Subject Code: 17503

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answers	Marking Scheme
Q.1	A) (a) Ans	**Attempt any THREE of the following:** **Draw flow diagram of water supply scheme from source to consumer.** **OR** 	Any one 04 M

Q.1	A)(b) Ans	*Enlist types of pipes. State the factors affecting selection of pipe material.* **Following are the types of pipes:** i) Cast iron pipe ii) Wrought iron pipe iii) Steel pipe iv) Concrete pipe v) Asbestos pipe vi) Copper pipe vii) Lead pipe viii) Plastic pipe ix) GI pipe **Factor affecting selection of pipe material**: i) Carrying capacity of the pipes. ii) Durability of pipe. iii) Type of water to be conveyed and its possible corrosive effects on the pipe material. iv) Availability of funds. v) Maintenance cost, repairs etc.	02 M for any eight 02 M for any four
Q.1	A)(c) Ans	*State any four qualities of good trap.* i) It should be simple in construction. ii) It should be non-absorbent material. iii) It should provide sufficient depth of water seal. iv) It should be self-cleansing. v) It should have smooth internal and external surface. vi) It should not obstruct the sewage flow. vii) It should have provision for means of access.	Any four 01 M for each
Q.1	A)(d) Ans	*Write step-by-step procedure of laying of sewers.* Following are the steps of laying of sewer. **Procedure of laying of sewer:** i) Marking the center line of sewer. ii) Excavation of trenches. iii) Bracing and dewatering of trenches. iv) Laying of sewer. v) Jointing of sewer. vi) Testing of sewer.	04 M

| Q.1	B) (a) Ans	*Attempt any ONE of the following:* *Compare any six points between Rapid sand filter & Slow sand filter.*	

| Item	Slow Sand Filter	Rapid Sand Filter
Pre treatment	Not required except plain sedimentation	Coagulation, Flocculation and Sedimentation
Base materials	Gravel base of 30 to 75 cm depth with 3 to 65mm size graded gravel.	Gravel base of 45 to 50 cm depth with gravel size varies from 3 to 50 mm in 4 or 5 layers
Filter sand • Effective size • Uniformity coefficient • Thickness of sand bed	• 0.25 to 0.35 mm • 3 to 5.0 • 80 to 100 cm	• 0.45 to 0.70 mm • 1.2 to 1.7 • 60 to 75 cm
Under drainage system	Open jointed pipes or drains covered with perforated blocks	Perforated pipe laterals discharging into main header
Size of each unit	50 to 200 sq.m	10 to 100 sq.m
Rate of filtration	100 to 200 Lph/sq.m	4800 to 7200 Lph/sq.m
Cost • Installation • O&M	• High • Low	• Low • High
Efficiency • Turbidity of feed water • Removal of bacteria	Low; < 30 NTU 98 to 99%	Any level of turbidity of feed water; (with pre-treatment) 80 to 90%
Suitability	For water supply to rural areas and small town	For public water supply to towns and cities
Post treatment	Slight disinfection	Complete disinfection is a must
Ease of construction	Simple	Complicated;
Skilled supervision	Not essential	Essential
Loss of head • Initial • Final	• 10c m • 80 to 120 cm	• 30 cm • 250 to 350 cm
Method of cleaning	• Scrapping and removing *Schmutzedecke* and 1.5 to 3 cm thick sand layer • Laborious	• Back washing with or without compressed air agitation • Simple and easy
Quantity of wash water required	0.2 to 0.5% of total water filtered	1 to 5% of the total water filtered
Cleaning Interval	Three to four months	One to two days

Any Six points 01 M for each

Q.1	B)(b)	*State the permissible limits as per I.S. for following parameters of drinking water:*	
		(i) Colour (ii) Hardness (iii) pH (iv) Turbidity (v) Chloride (vi) Temperature	
	Ans		01 M for each

Parameters	Permissible
a) Color	5 on platinum cobalt scale
b) Hardness	75 – 115 ppm (Max 600)
c) pH	6.5 to 8.5
d)Turbidity	5 - 10 NTU
e) Chlorides	Less than 250 mg/lit
f) Temperature	$10°C – 15.60^0C$

Q.2		*Attempt any FOUR of the following:*	
	(a)	*Enlist different methods of Aeration. Explain any one of them with neat sketch.*	
	Ans	Following are the methods of Aeration.	

Following are the methods of Aeration.

i) Cascade aerator.
ii) Spray Nozzles.
iii) Air diffusion method.
iv) Trickling bed method.

02 M

i) Cascade aerator.
They consist of concrete steps over which water comes down in thin sheet.
Weir may be provided at the edge of each step.
Thin sheet of water which comes down over steps comes in contact with the atmosphere. Fig. shows aeration by cascades.

Any one 02 M

ii) Spray Nozzles.
These are also known as spray aerators with special nozzles to produce a fine spray.
Each nozzle is 2.5 to 4 cm diameter discharging about 18 to 36 l/h. Nozzle spacing should be such that each m3 of water has aerator area of 0.03 to 0.09 m2 for one hour.

iii) Air diffusion method.
It consists of a tank with perforated pipes, tubes or diffuser plates, fixed at the bottom

to release fine air bubbles from compressor unit. The tank depth is kept as 3 to 4 m and tank width is within 1.5 times its depth. If depth is more, the diffusers must be placed at 3 to 4 m depth below water surface. Time of aeration is 10 to 30 min and 0.2 to 0.4 litres of air is required for 1 litre of water.
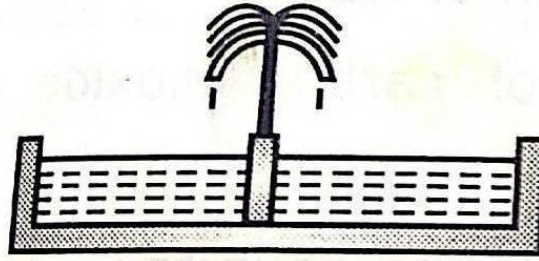
iv) Mechanical Aerators.
Mixing paddles as in flocculation are used. Paddles may be either submerged or at the surface.
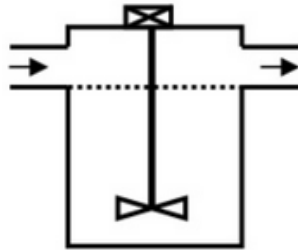
(Note: Students may explain any one of the above)

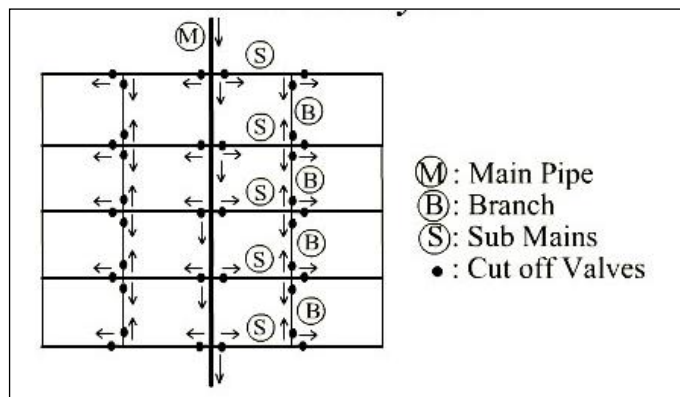|			
Q.2	(b) Ans	***Explain purpose of Grit Chamber. State its location.*** The grit chamber is used to remove grit, consisting of sand, gravel, cinder, or other heavy solids materials that have specific gravity much higher than those of the organic solids in wastewater. Purpose: i) To protect moving mechanical equipment from abrasion and abnormal wear. ii) Avoid deposition in pipelines, channels, and conduits. iii) To reduce frequency of digester cleaning.	03 M
		Location: Grit chamber is located after screen.	01 M
Q.2	(c) Ans	***Explain Grid iron system of water distribution with neat sketch.***	02 M

|			
		Grid iron system. This is also called interspaced or reticulation system. In this system, the water mains and branches are laid in rectangles. The sub-mains, mains and branches are interconnected with each other. **Advantages:** (a) In case of repairs, a very small portion of the distribution system area will be affected. (b) In case of fire, water is available from all directions. (c) As there are no dead ends, water circulates freely. (d) Loss of head is minimum at all points in the system. **Disadvantages :** (a) The cost of laying of water pipes is more. (b) Exact calculation of pipe sizes is difficult. (c) Long pipes are required. (d) More valves are required for operation.	01 M 01 M
Q.2	(d) Ans	***Enlist different types of sewer according to shape. Explain any one of them.*** Following are the types of sewer according to shape: i) Rectangular ii) Circular iii) Semi elliptical iv) Horse shoe v) Egg shaped **i) Rectangular** This is constructed with RCC which may be precast or cast in situ. This type of section used only for large discharges because for small discharges self-cleansing velocity will not be developed. **ii) Circular** These shape are more common now a days. This section gives the least perimeter for high area. This section is economical , can be easialy manufactured, transported. These pipe may be made of precast asbestos, RCC or steel.	Any four 1/2 M for each Any one 02 M
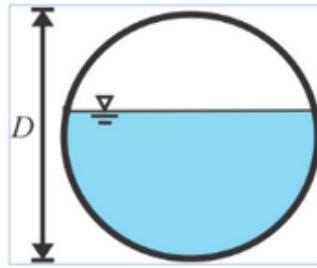
iii) Semi elliptical

This section is suitable for sewer carrying large discharge over long periods.It is structurally more stable, has a good hydraulic properties, it is usually constructed with RCC.

iv) Horse Shoe type

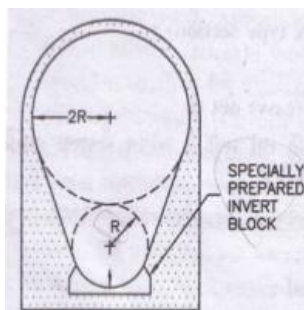This section has semicircular shape on the top with the side inclined. The invert may be circular or parabolic.
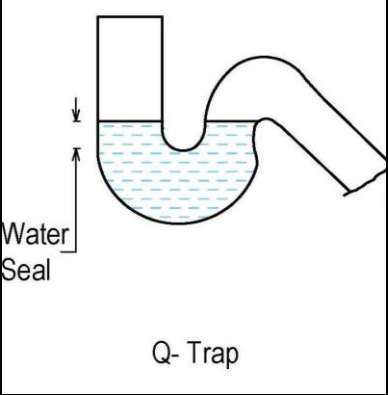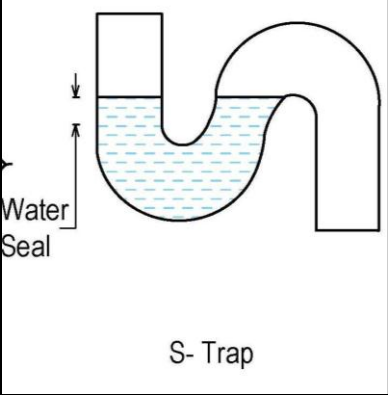It is constructed with RCC and is used for heavy discharge.
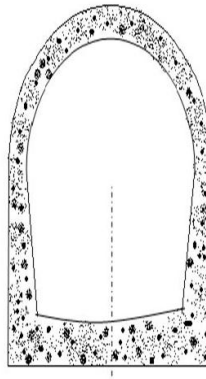
v) Egg shaped :

These type of sewer section are commonly used, because in dry weather self-cleansing velocity is available due to greater depth as compared to other sections.
It has good hydraulic properties, even better than circular section.

(Note : Students may explain any one type sewer)

Q.2	(e) Ans	**Draw a neat labelled sketch of 'Q' and 'S' trap.**	02 m for each
Q.2	(f) Ans	**State the importance of building sanitation.** Building sanitation is important because of following reasons: 1) It helps in preventing the occurrence of diseases such as typhoid, malaria, smallpox, chickenpox etc. 2) It helps in collecting and disposing off the waste of the community in systematic way. 3) It helps in preventing the pollution of natural streams and rivers. 4) It helps in protecting water supplies from pollution. 5) It helps in maintaining good environments for the health of the public. 6) It helps in development of city. 7) It helps in removing rain water from a town	Any four 01 M for each
Q.3	(a) Ans	**Attempt any FOUR of the following:** **Enlist different types of Intakes. Explain anyone with neat sketch.** Following are the different types of intake structures: i) Canal intake ii) Reservoir Intake iii) River Intake iv) Lake Intake **i)Canal Intake:** A canal intake consists of pipe placed in brick masonry chamber constructed partially in canal bank. On the one side of the chamber, an opening is provided with coarse screen for the entrance of water. The end of the pipe inside the chamber is provided with bell mouth fitted with fine screen. The outlet pipe carries the water to the other side of canal bank, from where it is taken to water treatment plant.	01 M Any one 02 M for fig. and
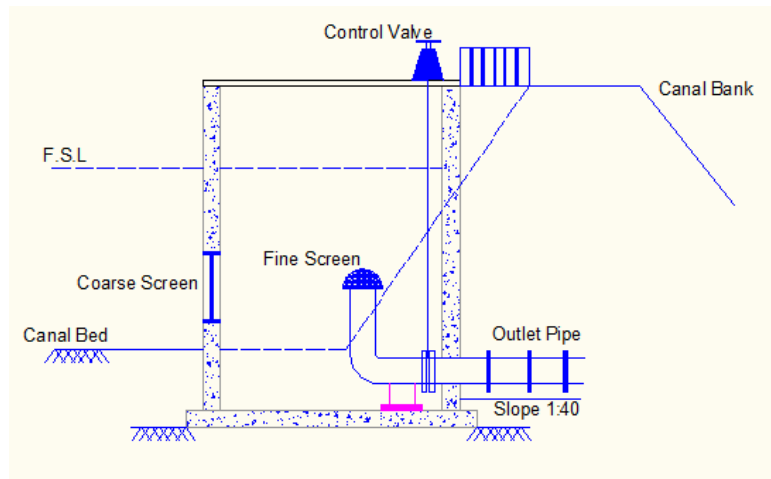
As the water level in the canal remains more or less constant , there is no need of providing pipes at various levels.

ii)Reservoir Intake:

A reservoir is formed by constructing a dam or weir across the river. The dam may be earthen dam, masonry dam or concrete dam. Since the water level in reservoir changes from time to time, intake pipes are provided at different levels.
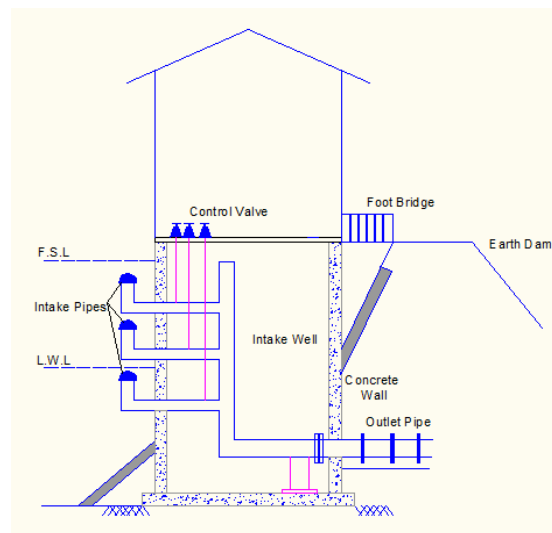

Fig .shows intake tower constructed on the slope of the dam. Screens are provided to the intake pipes and are controlled by sluice valve provided to control water flow.

iii) Lake Intake

For obtaining water from lakes, mostly submersible intakes are used. These intakes are constructed in the bed of the lake, which consists of pipe and bell opening, protected by timber or concrete crib. Water is flow from the opening and is collected in sump well and then pumped to the treatment plant.
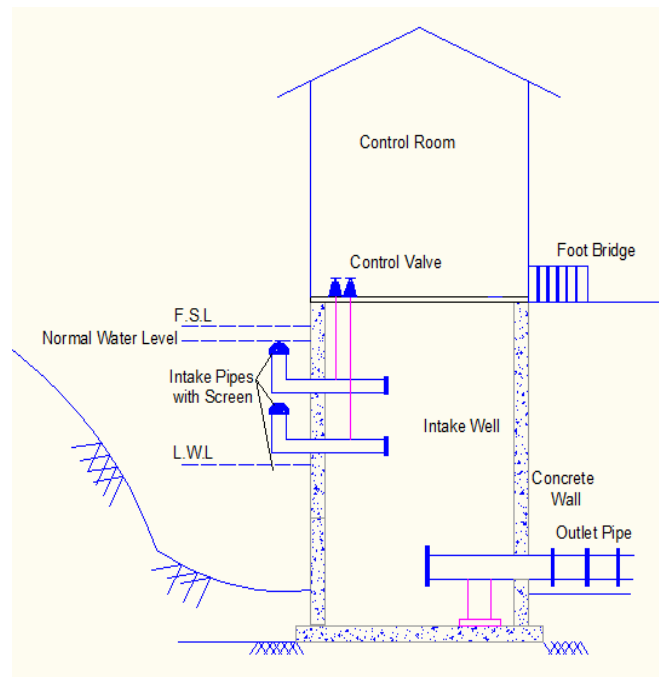
01 M for explanation
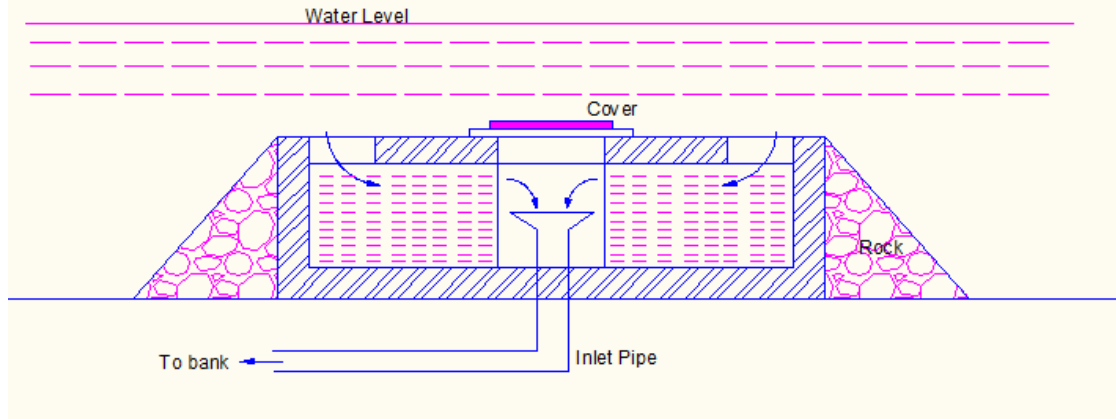
iv)River Intake:

It is circular masonry tower of 4 to 7 m diameter. It is constructed along the river bank at a place from where water can be drawn in required quantity.

River intake may be,
a) Wet intake.
b) Dry Intake.
c) Movable intake.

(Note : Students may explain any one type of intake structure)

Q.3	(b) **Differentiate between one pipe and two pipe system of plumbing.**
	Ans

Differentiate between one pipe and two pipe system of plumbing.

One pipe plumbing System	Two pipe plumbing System	
In this system there is only one set of pipe.	In this system there are two sets of pipes.	01 M for each point
All the waste matter from WC, bath, sinks etc. is discharge through one pipe.	There is one pipe to collect foul soil and lavatory waste and second pipe collect waste from kitchen , bathroom etc.	

| Simple plumbing system. | Difficult in construction. | |
| economical | Costly as compare to one pipe system | |

Q.3 (c) Ans *Explain construction and working of Standard rate trickling filter. Also state its advantages & disadvantages.*

A trickling filter is an artificial bed of stone or broken brick material, over which waste water is distributed and applied in drops as shown in fig.

A slim layer is formed on the surface media, in which bacteria are there to consume the organic matter

Advantages:
i) Simple in construction.
ii) Reduce BOD to the extent of 75%.
iii) Flexible in operation.
iv) Give highly nitrified and stabilized effluent.
v) Do not require skilled supervision.

Disadvantages:
i) High construction cost.
ii) Bad smell and fly nuisance.
iii) Require primary treatment.
iv) Require larger area.

02 M / 01 M / 01 M

Q.3 (d) Ans *State any four factors affecting demand of water.*
factors affecting demand of water
i) Size of city: Demand of water α Size of city.
ii) Habits of people: Demand of water α Living standard.
iii) Climatic conditions: Summer – More, Winter – Less, Rainy – Very less.
iv) Cost of water: Demand of water α (1/Cost).
v) Commerce and industry: Increases Demand of water.
vi) Quality of water: Increases Demand of water.
vii) Efficiency of water supply system:
viii) System of sanitation: Demand of water α System of sanitation.
ix) System of supply: Continuous and intermitant.
x) Metering of supply: Reduces demand of water.

Any four 01 M for each

Q.3 (e) Ans *What is water conservation? State the necessity of ground water recharging*
Water conservation: Water conservation includes all the policies, strategies and

		activities to sustainably manage the natural resource of fresh water, to protect the hydrosphere, and to meet the current and future human demand.	02 M
		Necessity of ground water recharging	
		i) No space is required for building reservoir	
		ii) Cost of building reservoir by recharging aquifer is considerably less.	
		iii) Quality of water obtained from underground reservoir is good as compared to surface reservoir.	02 M
		iv) Loss of water due to evaporation is much less than the water lost from surface reservoir.	
Q.4	(A) (a)	**Attempt any THREE of the following:**	
		Draw a neat sketch of clariflocculator.	
	Ans		Neat sketch 02 M Labeling 02 M
Q.4	(A)(b) Ans	**Enlist flushing cisterns. Explain any one of them.**	
		1. **Low-Level Cistern**: A cistern intended to operate at a height not exceeding 30 cm between the top of the pan and the underside of the cistern.	Enlist 03 M
		2. **Coupled Cistern**: cistern intended to operate sitting on flat surface provided at the back portion of wash down water-closets.	Explain any one 01 M
		3. **Dual-Flush Cistern**: A construction that enables the user to cause a short flush of partial discharge when only urine needs to be flushed away instead of the customary full flush.	
Q.4	(A)(c) Ans	**State systems of sewerage and describe any one.**	
		The sewerage system can be of following three types:	
		1. Combined system:	03 M
		2. Separate System:	
		3. Partially separate system:	
		1. Combined system:	
		In combined system along with domestic sewage, the run-off resulting from storms is carried through the same conduit of sewerage system. In countries like India where actual rainy days are very few, this system will face the problem of maintaining self-cleansing velocity in the sewers during dry season, as the sewage discharge may be far	

		lower as compared to the design discharge after including storm water.		
		2. Separate System: In separate system, separate conduits are used; one carrying sewage and other carrying storm water run-off. The storm water collected can be directly discharged into the water body since the run-off is not as foul as sewage and no treatment is generally provided. Whereas, the sewage collected from the city is treated adequately before it is discharged into the water body or used for irrigation to meet desired standards. Separate system is advantageous and economical for big towns. **3. Partially separate system**: In this system part of the storm water especially collected from roofs and paved courtyards of the buildings is admitted in the same drain along with sewage from residences and institutions, etc. The storm water from the other places is collected separately using separate storm water conduits.		Any one 01 M

Q.4	(A)(d) Ans	*Differentiate between aerobic & anaerobic process.*		

Differentiation points	Aerobic process	Anaerobic process
How it Works	Aerobic processes use bacteria that require oxygen, so air is circulated throughout the treatment tank. These aerobic bacteria then break down the waste within the wastewater.	Anaerobic bacteria (bacteria that live in environments that contain no oxygen) transform organic matter in the wastewater into biogas that contains large amounts of methane gas and carbon dioxide. Energy-efficient process.
Why it is Used	Used in rural areas or small communities where central sewage systems would be costly or impractical to implement.	No air input required and generates much less sludge (50-80% less) than aerobic treatment.
Maintenance Issues	Electrical and Mechanical parts require regular inspection and maintenance.	Optimal operation of municipal anaerobic treatment systems is dependent upon warmer temperatures that exist around 35°C.
Costs and Concerns Associated with Use	Aerobic treatment units (ATUs) are more expensive to operate than typical septic systems.	Require lower costs to handle sludge than aerobic treatment systems. Read more:

(01 M for each point)

Q.4	(B) (a)	*Attempt any ONE of the following:* *The following is the population data for a Town. Water supply scheme is to be designed for this town with a Design period of 30 years. Find the population at the end of year 2041 by Incremental increase method; also calculate total demand of water.*		

Year	1971	1981	1991	2001	2011
Population	39701	50157	68107	93351	115307

Q.4	Ans	population after n^{th} decade is		

				01 M

$P_n = P + n*X + \{n (n + 1)/2\}*Y$

Where, P_n = Population after n^{th} decade

X = Average increase

Y = Incremental increase

Year	Population	Avg. increase (X)	Incr. increase(Y)
1971	39701	----------	---------
1981	50157	10456	---------
1991	68107	17950	+7494
2001	93351	25244	+7294
2011	115307	21956	-3288
	TOTAL	75606	11500
	AVERAGE	18901	3833

02 M

Population in year 2021 is, P2021 =115307+(18901X1)+ {(1 (1+1))/2}X3833=1,38,041

Population in year 2031 is, P2031 =115307+(18901X2)+ {(2 (2+1))/2}X3833=1,64,608

Population in year 2041 is, P2041 =115307+(18901X3)+ {(3 (3+1))/2}X3833=**1,95,008**

02 M

Total domastic demand of water = 135 x 195008 = **2,63,26,080 liter**

Total demand of water. = 270 X 195008 = **5,26,52,160 liter**

01 M

Q.4 (B)(b) Ans

Explain working of septic tank with neat sketch.

02 M

Working of septic tank: Septic tanks can be made from concrete, masonry or fiberglass. Prior two are of rectangular shape and later is generally of circular shape. The inlet and outlet are baffled so that the floating matter and grease will be retained in the tank. Heavy solids settle at the bottom of the tank, where the organic fraction will decompose following anaerobic pathway. The production of biogas may interfere with the sedimentation of the solids. Every septic tank should be provided with the ventilation pipe with the top of the pipe covered with suitable mosquito proof wire mesh. The top of the pipe should extend to at least 2 m above the highest building height present in the vicinity of 20 m from the septic tank.

02 M

Q.5

(a) Ans

Attempt any FOUR of the following:

Explain zeolite process of water softening.

This is also known as the base-exchange or ion-exchange process. The zeolite process is compounds of aluminium, silica and soda .they have got the excellent property of interchanging base.

The most common artificial zeolite is the permutit.it is manufactured from feldspar, kaolin clay and soda. These chemicals are mixed in the required proportion and then the mixture is fused in a furnace .it is allowed to cool after attaining certain degree of fusing.

| | | The material thus formed is then crushed to form particles of diameter varying from 0.25 mm to 0.50 mm.it is then washed to remove all alkalies and impurities. The permutit is white in colour and its chemical formula is 2SiO2Al2O3.Na2O.the chemical composition is as follows.

Alumina---------22%
Silica-------------46%
Water-------------18.4%
Sodium oxide-----13.6%

The exchange value of permutit is 35000gm to 41000gm of hardness per m3 of zeolite .the chemical reaction involved in the process when permutit is used.

$2SiO_2Al_2O_3.Na_2O+Ca(HCO_3)2 \rightarrow 2SiO_2Al_2O_3\ CaO+2\ Na\ HCO_3$
$2SiO_2Al_2O_3.Na_2O+CaSO_4 \rightarrow 2SiO_2Al_2O_3CaO+ Na_2\ SO_4$
$2SiO_2Al_2O_3.Na_2O+CaCl_2 \rightarrow 2SiO_2Al_2O_3CaO+2\ NaCl$

Thus hard water comes into contact with zeolite the calcium and magnesium are removed is given in exchange. Thus the hard water is softened and its sodium content is increased as indicated by the above process.
After some process, the sodium present in zeolite is exhausted as the entire sodium zeolite has been converted to calcium zeolite and magnesium zeolite. This is regenerated by passing a solution of salt through the zeolite. | 04 M |
| Q.5 | (b)

Ans. | ***State the location and function of the following pipe fittings:***
(i) Air Valve   (ii) Reflux Valve   (iii) Scour Valve   (iv) Sluice Valve

(i) Air Valve :
    Function: some quantity of air is contained in the flowing water and this tries to accumulate at high points and this air tries to accumulate at high points along the water pipe.in order to provide an exit for such accumulated air the air valve are provided at summit along the water pipe.
    Location: the air valves should be located at points which are close to or above the hydraulics gradient.

ii) Reflux valve:
    Function: a reflux valve is an automatic device which allows water to go in one direction.
    Location: the reflux valve is invariably placed in water pipe which contains water directly from pump.

iii) Scour valve:
    Function: they are operated to remove sand or silt deposited in the water pipe.
    Location: they are located at dead ends and depressions or lowest points in main.

iv) Sluice valves:
    Function: these valves control the flow of water and are helpful in dividing the water mains in to suitable section.
    Location: these are placed at a distance of about 150m to 200m and at all junctions. | 01 M for each (1/2 M for function and 1/2 M for location) |

Q.5	(c) Ans.	*Draw sectional elevation of 'Drop Manhole'. Label the parts & state its location.*	
			02 M
		Drop manhole is used to indicate the manhole on sewer line which is constructed to provide a connection between the high level branch sewer to extent of about 500mm to 600mm above the main sewer to the low-level main sewer with a minimum amount of disturbance.	02 M
Q.5	(d) Ans.	*Define B.O.D. State its significance in sewage treatment.* **Definition**: The amount of oxygen required for microbes to carry out the biological decomposition of dissolved solids or organic matter in sewage under aerobic condition at slandered temperature is known as the B.O.D.	02 M
		Significance: i) B.O.D. is the principal test, which gives an idea of the biodegradability of any sample and strength of the waste. ii) B.O.D.is an important parameters in the design of treatment plant to determine the size of certain units particularly trickling filters and activated sludge process. iii)B.O.D.is useful to estimate the population equivalent of any industrial waste, which is useful to collect cess from industrialist for purification of industrial waste in municipal sewage treatment plants. iv) B.O.D.is used in studies to measure the self-purification capacity of streams and serves as a means of check to regulatory authorities on the quality of effluents discharged. v) From B.O.D. of the effluent and effluent discharged, the efficiency of treatment plant can be judge.	02 M
Q.5	(e) Ans.	*Enlist methods of distribution of water. Explain any one of them* Methods of distribution of water 1.Gravity System 2. Gravity And Pumping System. 3. Pumping System.	01 M
		1. **Gravity System**: In this system, the water is conveyed through pipes by gravity only. This gravity system is the most reliable method off distribution. But it is useful only when the source of water supply is situated at higher level than that	

of distribution area. The fig. shows the gravity system with hydraulic gradients during maximum and minimum demands.
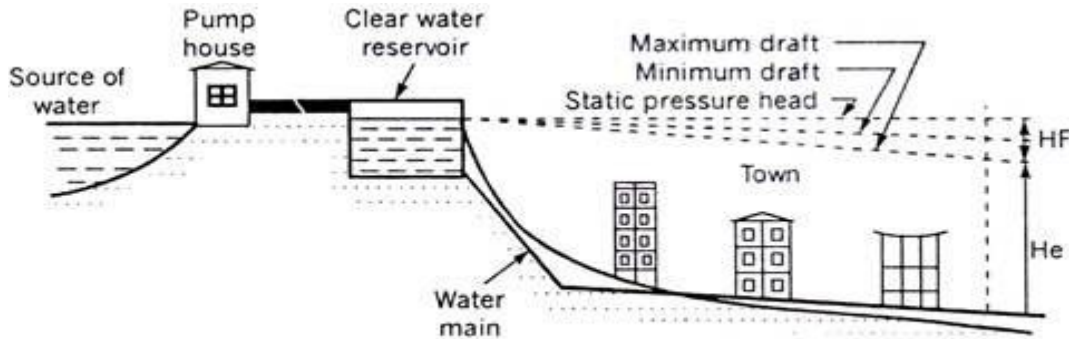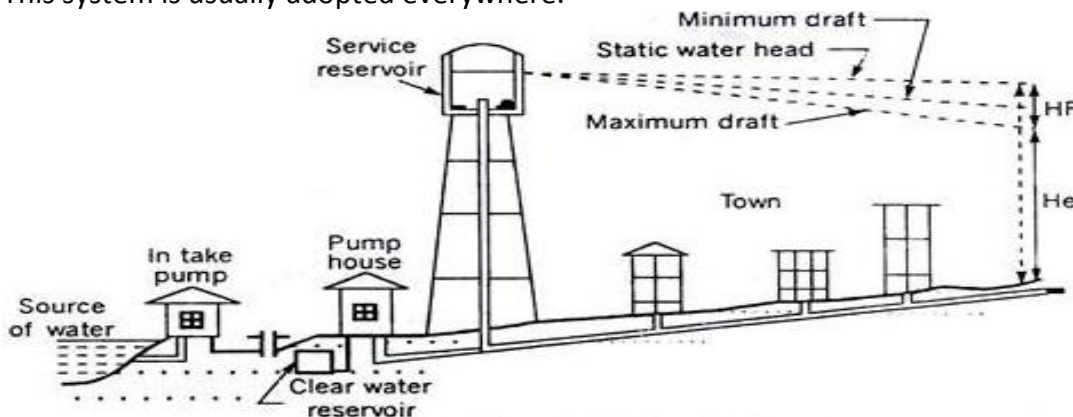

Gravity System of Distribution.

Any one
03 M

2. Gravity And Pumping System.

This is also known as combined gravity and pumping system. The pump is connected to the mains as well as to an elevated reservoir. In the beginning when demand is small the water is stored in the elevated reservoir, but when demand increases the rate of pumping, the flow in the distribution system comes from both the pumping station as well as elevated reservoir.

As in this system water comes from two sources one from reservoir and second from pumping station, it is called dual system. This system is more reliable and economical, because it requires uniform rate of pumping but meets low as well as maximum demand. The water stored in elevated reservoir meets the requirements of demand during breakdown of pumps and for fire fighting.

Fig. shows this system with hydraulic gradient lines for minimum and maximum draft. This system is usually adopted everywhere.


Dual System of Distribution.

3. Pumping System.

In this system water is directly pumped in the mains. Since the pumps have to work at different rates in a day, the maintenance cost increases. It is preferred to have number of pumps and only the required numbers may work at various times to meet the varying demand, in place of providing pump of variable speed. High lift pumps are required and their operations are continuously watched.
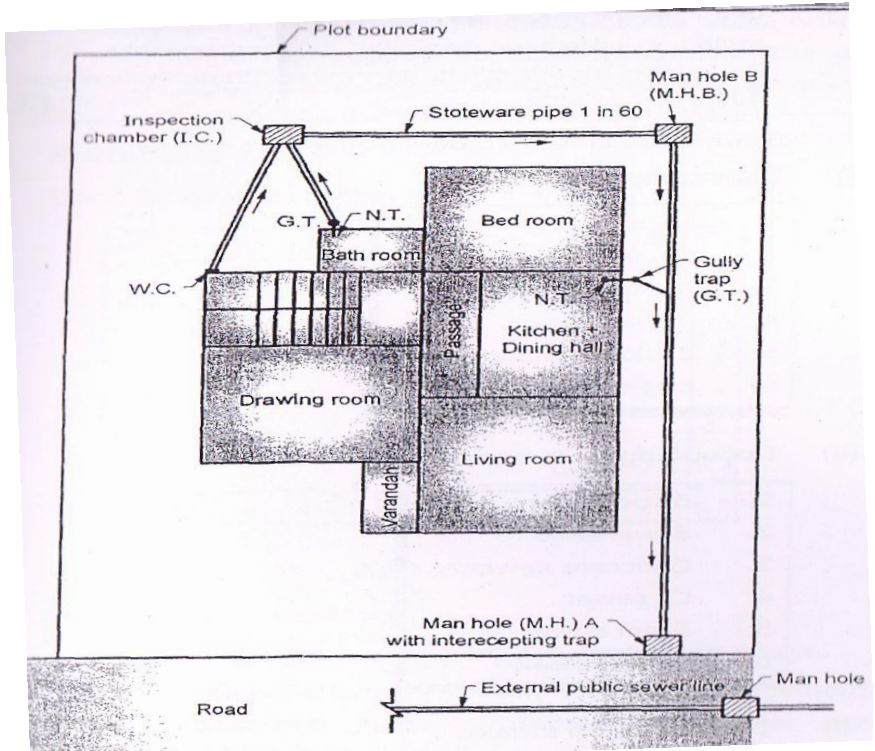
If the power fails, the whole supply of the town will be stopped. Therefore, it is better to

have diesel pumps also in addition to the electric pumps as stand bye. During fires, the water can be pumped in the required quantity by the stand-bye units also. But this system is not preferred than other systems. The required pressure maintained in the pipe line is by direct pumping as shown in Fig.

Pumping System of Distribution.
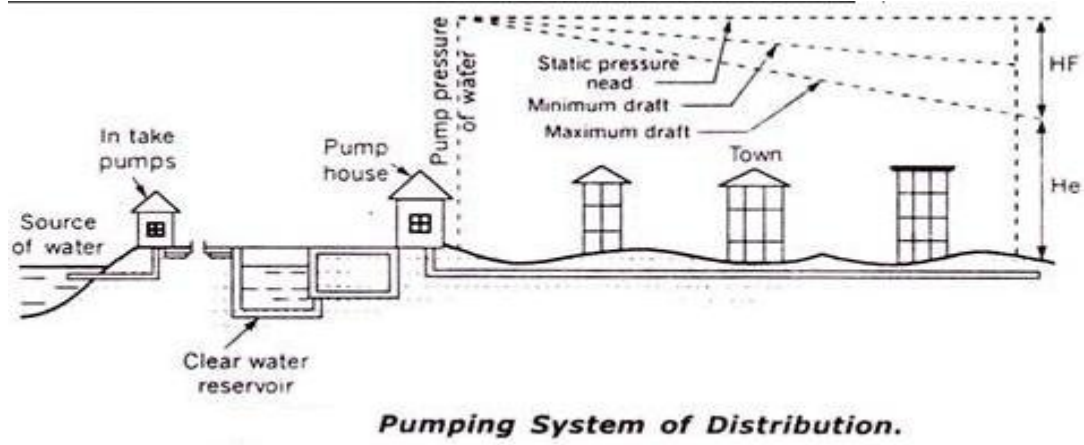
| Q.5	(f) Ans.	Draw the layout of sanitary plumbing and sewage collection of residential building.	04 M
Q.6	(a) Ans.	Attempt any FOUR of the following: Enlist four forms of chlorination. Explain break point chlorination with graph. **Forms of chlorination**: a) plain-chlorination b) pre-chlorination c) post-chlorination d) double-chlorination e) break point-chlorination f) super-chlorination g) de-chlorination	Any four 1/2 M for each

Break point chlorination:

The graph below shows the phenomenon when chlorine (either chlorine gas or a hypochlorite) is added to water. First (between points 1 and 2), the water reacts with reducing compounds in the water, such as hydrogen sulphide. These compounds use up the chlorine, producing no chlorine residual.

02 M
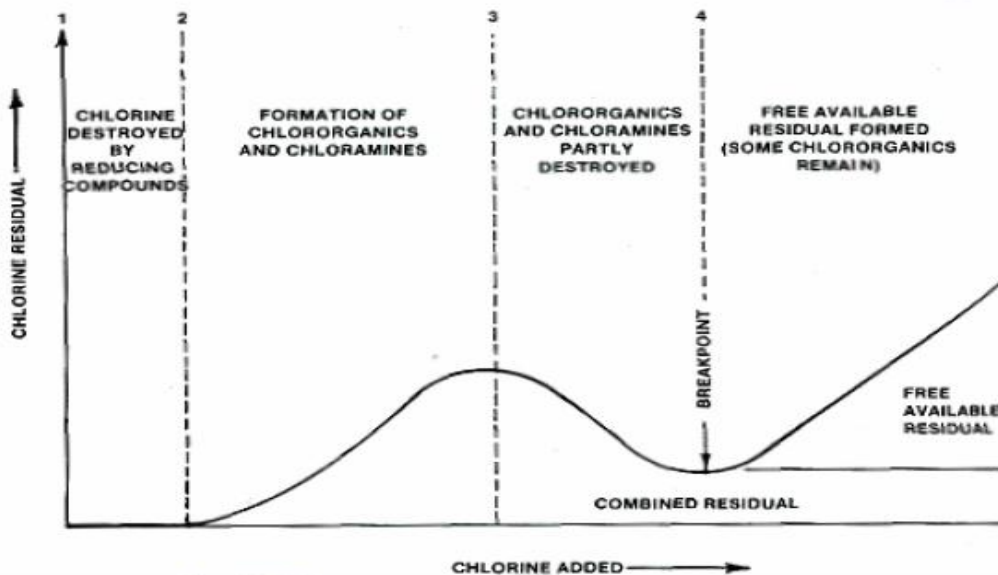
between points 2 and 3, the chlorine reacts with organics and ammonia naturally found in the water. Some combined chlorine residual is formed -chloramines. Note that if chloramines were to be used as the disinfecting agent, more ammonia would be added to the water to react with the chlorine. The process would be stopped at point 3.Using chloramine as the disinfecting agent results in little trihalomethane production but causes taste and odor problems since chloramines typically give a "swimming pool" odor to water. In contrast, if hypochlorous acid is to be used as the chlorine residual, then chlorine will be added past point 3. Between points 3 and 4, the chlorine will break down most of the chloramines in the water, actually lowering the chlorine residual. Finally, the water reaches the breakpoint, shown at point 4. The breakpointis the point at which

the chlorine demand has been totally satisfied - the chlorine has reacted with all reducing agents, organics, and ammonia in the water. When more chlorine is added past the breakpoint, the chlorine reacts with water and forms hypochlorous acid in direct proportion to the amount of chlorine added. This process, known as breakpoint.

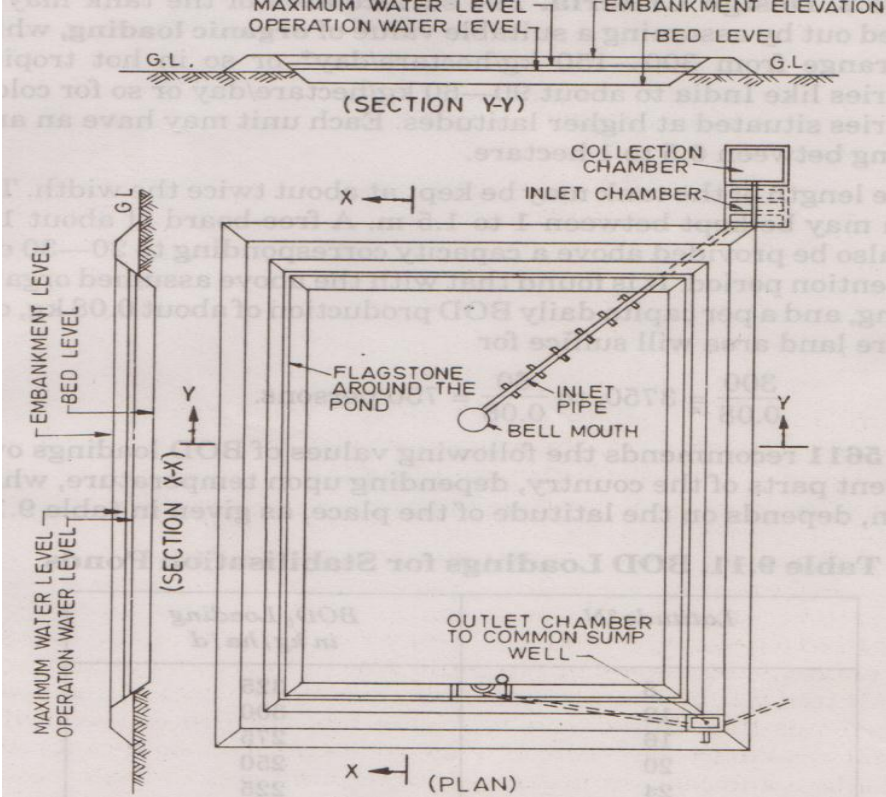| Q.6	(b) Ans.	*State necessity of inspection & junction chamber with its location.*	
		Necessity of inspection & junction chambers:	
		a) They permit inspection, cleaning and maintenance of sewer lines. The obstruction in sewage flow is collected in manholes and they are then brought to the surface.	
		b) The manholes allow the joining of sewers or of changing the direction or alignment or both .a manholes sometimes receives the contribution of sewages from sewers from sewers of various sizes and coming from various direction.	03 M
		c) If manholes coves are perforated. The manholes may allow the escapes of undesirable gases and thus the ventilation of sewers can be achieved to a great extent.	
		d) The manholes facilities the laying of sewers lines in convenient lengths.	
		Location: The manholes are provided at every bend, junction, change of gradient or	01 M

		change of diameter.	
Q.6	(c)	*Explain working of oxidation pond with neat sketch.*	
	Ans.		02 M
		• The oxidation pond purify sewage by dual action of aerobic and algae.	
		• The sewage is stored under climatic condition which is favorable for the growth of algae, namely sunshine and warmth.	
		• Aerobic bacteria use oxygen of the atmosphere, whereas the algae are active in the sunlight.	
		• Due to the dual process of photosynthesis acting on the sewage, it breaks up the carbon dioxide produced during the carbon cycle from the carbohydrates present in the sewage. This carbon is used in producing more carbohydrates and released oxygen keeps the dissolved oxygen content of water at high level.	02 M
Q.6	(d) Ans.	*State the preventive measures to avoid pollution of bores & wells.* 1. Vulnerability assessments. 2. Hazard surveys. 3. Proper siting of wells and hazards. 4. Performance criteria for hazards. 5. Monitoring of well water quality. 6. Assessments of water quality data. 7. Well construction and sanitary protection. 8. Disinfection. 9. Public awareness.	Any four 01 M for each
Q.6	(e) Ans.	*State significance of rain water harvesting. Explain anyone method of it.* **Significance:-** i. To overcome the inadequacy of surface water to meet our demands.	

		ii. To arrest decline in ground water levels. iii. To enhance availability of ground water at specific place and time and utilize rain water for sustainable development. iv. To increase infiltration of rain water in the subsoil this has decreased drastically in urban areas due to paving of open area. v. To improve ground water quality by dilution. vi. To increase agriculture production. vii. To improve ecology of the area by increase in vegetation cover etc.	03 M
		(i) Storage or Recharge - Based on the type of usage, structures can either be used to store the collected water for direct use or to recharge groundwater. **(ii) The Urban-Rural Difference** - Urbanization has resulted in the shrinking of open spaces as well as unpaved areas. This has resulted not only in flooding of cities but has also caused water scarcity due to groundwater depletion in general and saline intrusion in coastal cities. While rural harvesting is mostly traditional and is carried out in surface storage bodies like rivers, tanks, ponds, lakes etc., urban harvesting, due to lack of open space for capturing the runoff, is mostly in sub-soil storage as groundwater recharge. **(iii) Rooftop and Drive-Way Harvesting -** This greatly restricts the scope of rainwater harvesting as a considerable amount of water that falls around the built up area is let out of the building as run-off. Driveway run-off water should not be move away.	Any one 01 M