## Important Instruction to Examiners:-

**1) The answers should be examined by key words & not as word to word as given in the model answers scheme.**

**2) The model answers & answers written by the candidate may vary but the examiner may try to access the understanding level of the candidate.**

**3) The language errors such as grammatical, spelling errors should not be given more importance.**

**4) While assessing figures, examiners, may give credit for principle components indicated in the figure. The figures drawn by candidate & model answer may vary. The examiner may give credit for any equivalent figure drawn.**

**5) Credit may be given step wise for numerical problems. In some cases, the assumed contact values may vary and there may be some difference in the candidate's answers and model answer.**

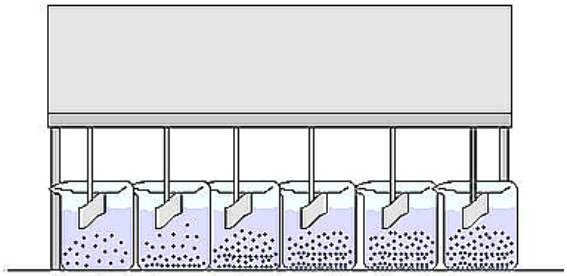
**6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding.**

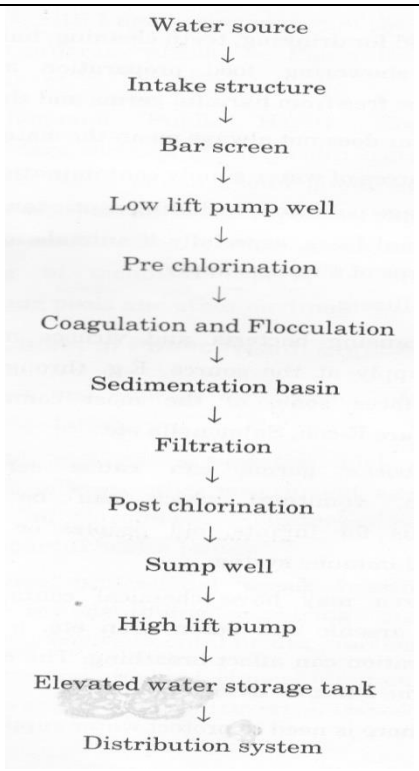
**7) For programming language papers, credit may be given to any other programme based on equivalent concept.**

## Important notes to examiner

| Q .NO | SOLUTION | MARKS |
|---|---|---|
| Q.No.1A | **Attempt Any Three of the following:** | 12 M |
| a) | **State any four factors affecting rate of demand. Explain any one in detail.** | 04 M |
| | **Factors affecting rate of demand**<br>1) Size of city<br>2) Climate conditions<br>3) Metering system<br>4) Supply and pressure<br>5) Habits of people<br>6) Quality of water<br>7) Cost of water<br>8) Industries and commerce<br>9) System of supply<br>10) System of sanitation<br>**1) Size of city**: In small cities, it was found that the per capita per day water consumption was small due to the fact that there are only limited uses of water in those cities. Small cities have larger area that is inadequately served by both water and sewer systems than larger cities.<br>**OR**<br>**2) Climate conditions:** At the place where summers are very hot and dry, the consumption of water is more. In summer domestic and public use increases as compared to winter.<br>**OR**<br>**3) Metering system:** The quantity of water supplied to a building is recorded by water meter and the consumer is then charged accordingly.<br>**OR**<br>**4)Supply and distribution pressure:** frequent change in pressure it will leads to Waste.<br>**OR**<br>**5) Habits of people: it** is depends upon the living standards of people and it are varies from urban to rural areas.<br>**OR**<br>**6) Quality of water:** if the quality of water gets lowered then people will not use that water and look for another source of water.<br>**OR**<br>**7) Cost of water:** cost at which water is supplied consumer may also affect the rate of demand, higher the cost lower will be the demand.<br>**OR**<br>**8) Industries and commerce:** This is the amount of water used by the shops, markets, industries, factories etc. It contributes 15 – 24% of total use of water. It includes factories, offices and commercial places demand. It is based on either having a separate or combined water supply system. Demand of water based on unit production: No. of persons working and floor area.<br>**OR**<br>**9)System of sanitation**<br>If the underground drainage is provided in the town, more quantity of water is used in flushing water closets and urinals.<br>**OR** | **½ M for Each Write Any Four**<br>**2M for explanation Any One** |

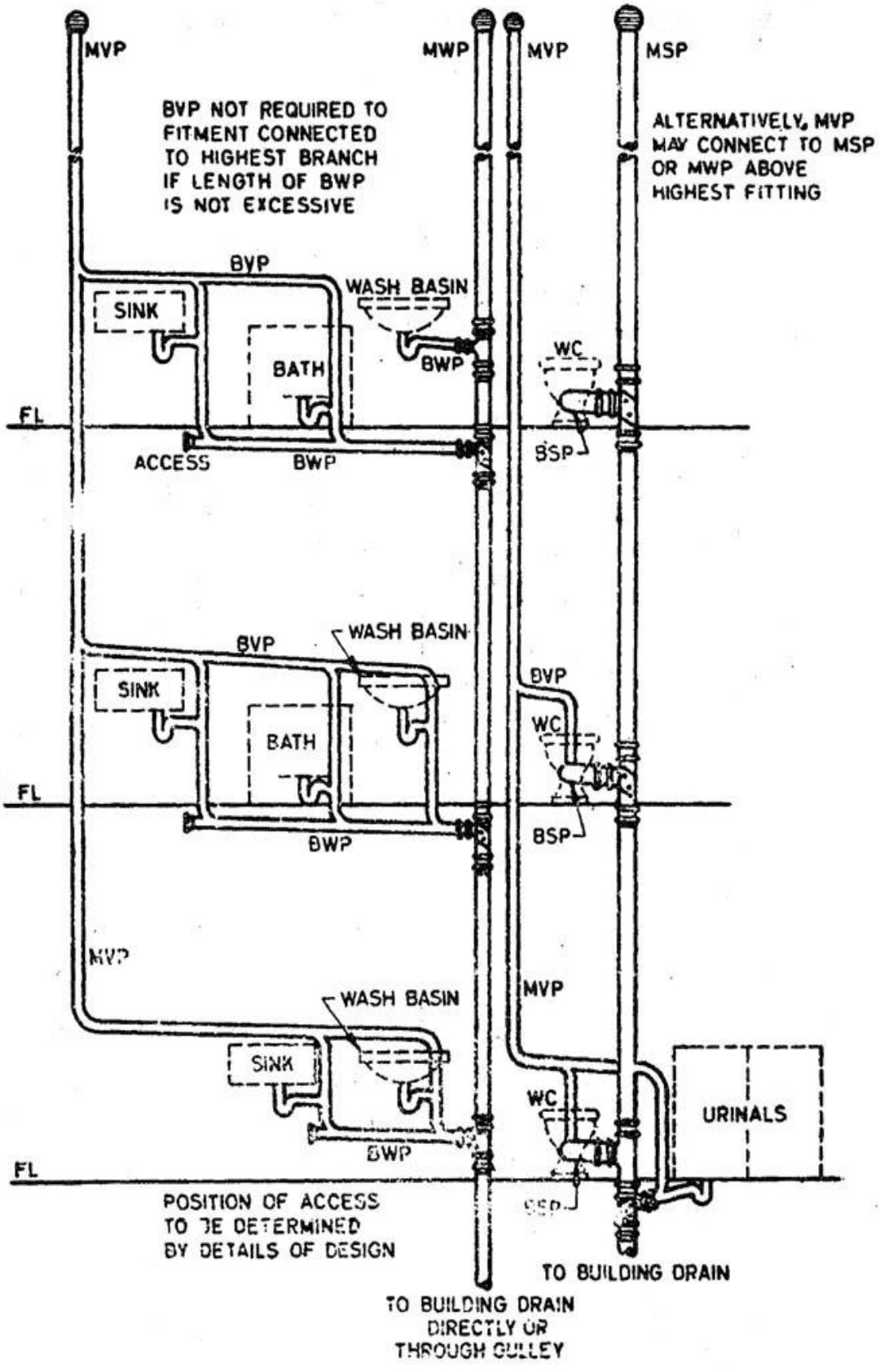
| | | |
|---|---|---|
| | **10)System of supply-:**<br>• Supply may me continues or intermittent.<br>• Intermittent system reduces consumption of water.<br>• But sometimes open taps and stored water causes wastage of water. | |
| **b)** | **Enlist four bacteriological tests need to be conducted on water.** | **04 M** |
| | 1)E-coli index, in this three tests are there<br>i)presumptive test<br>ii)confirmatory test<br>iii)completed test<br>2) MPN-Most probable number test.<br>3) Total Count or Agar Plate Count Test. | **1M for Each** |
| **c)** | **Define aeration. Enlist different methods of aeration.** | **04 M** |
| | **Aeration:** the process of exposing large surface of water to atmosphere or air is called as aeration.<br>**Different methods of aeration**<br>➢ By using fountains, spray nozzles<br>➢ Gravity or free fall aeration<br>a)cascade aeration<br>b)inclined aeration<br>➢ Trickling method<br>➢ By air diffusion | **01 M**<br>**01 M Each** |
| **d)** | **Define sedimentation. State different types of sedimentation tanks.** | **04 M** |
| | **Sedimentation**: The process by which suspended particles settle down under the influence of gravity known as sedimentation.<br>**A)Depending upon the nature of working**<br>i)fill and draw type<br>ii)continuous flow type , it may be vertical and horizontal type<br>**B) Depending on the shape**<br>i) Square<br>ii) Rectangular<br>iii) Circular<br>**C) Depending on direction of flow**<br>i) Vertical type<br>ii)Horizontal type | **01 M for definition**<br>**01 M for Each types** |

| | | |
|---|---|---|
| **B)** | **Attempt any ONE of the following :** | **06 M** |
| **a)** | **Enlist six factors to be considered while selecting site for intake.** | **06 M** |
| | ➢ Site should be near to the treatment plant, it must reduce the transportation cost<br>➢ It never is located near the navigation channel to reduce pollution problem and sewage disposal.<br>➢ Site should provide greater withdrawal of water if required in future<br>➢ intake must be located at a place from where it can be drawn even during the driest period of the year<br>➢ the intake should be easily accessible during floods<br>➢ In meandering rivers the intake should not located at curves.<br>➢ There should be no heavy currents of water which might endanger the safety of intake works.<br>➢ The site should provide best quality of water in order to minimize the cost of purification. | **1 M For each Point Any Six** |
| **b)** | **Explain with neat sketch Jar Test.** | |
| |  <br>**Jar test**<br>**Equipment used** :<br>• 6 jar vessels (beakers)<br>• Water sample whose temperature and pH is known.<br>• Scale for weighing chemicals<br>• Alum<br>**procedure**<br>➢ Fill the 6 jars with 1000ml water.<br>➢ Add the coagulant(alum) in the dosage of increasing order and stir the stirrer with 100 rpm for one minute<br>➢ Reduce the speed to 30 to 40 rpm<br>➢ Then allow the pedals to rotate slowly for 20 minutes<br>➢ Turn off the mixer and allow to settle for 30 minutes<br>➢ Observe and measure the turbidity of each jar sample<br>➢ Good floc formation will be the final amount of coagulant<br>➢ It is the optimum dosage | **02 M for sketch**<br>**02 M for procedure** |

| Q.No.2 | Attempt any FOUR of the following : | 16 M |
|---|---|---|
| a) | Draw flow diagram for, water treatment plant, state one function Units of any four Units. | 04M |
| |  <br>**1) Intake structure:** raw water from surface source is drawn into pant through intake structures<br>**2) Bar screens:** to remove the floating material and debris in the raw water.<br>**3) Low lift pump well**: lift the water to flow through treatment process by gravity<br>**4) Primary disinfection**: to disinfect the water by chlorination, if necessary<br>**5) Coagulation**: to add the coagulant in water, which add rapid electrochemical charges that attract small particle in water to clamp together as a floc.<br>**6) Sedimentation**: flocculated water applied to large volume tanks where the flow speed slows down and the dense floc settles in sedimentation tank<br>**7)Filtration:** remaining impurities are removed by filters<br>**8)Sump well:** filtered water is then stored in sump well<br>**9)High lift pump well:** treated water pumped through pressure to other station within the local district system<br>**10) ESR**: it ensures the required pressure in distribution.<br>**11)Distribution system:** these are the mains which deliver water to residential unit | **2M for flow diagram and**<br>**½ M For Each Functions Write Any Four** |
| b) | State the theory of filtration. | 04 M |
| | 1) **Mechanical Straining** •Simplest action during filtration. •Suspended particles having size more than that of filter voids are arrested and removed, when water passes through filter media. •Takes place in few centimeters of depth of filter media.<br>2) **Sedimentation** •Finer particles are arrested by sedimentation. •Continuous voids of filter media acts as 'tube settler' i.e. shallow depth sedimentation tank. •All colloids are removed by this action.<br>3) **Biological Action** •after few days of working of filter, upper grains of sand layer becomes coated with a reddish brown colored sticky deposit. •It consists of organic matter and Fe, Mg, Al and silica. | **1 M**<br>**1 M**<br>**1 M** |

| | | |
|---|---|---|
| | Further after 2-3 weeks, a film consisting of algae and protozoa etc is Developed. •This film is known as 'dirty skin' or 'Schmutzdecke'. •Organic impurities in water are used as food by this film, thus removing the organic Matter from water.<br>**4) Electrolytic Action** •Particulate matter is removed by electrostatic action. •Charge on filter medium neutralizes charge on floc particles, thereby permitting the floc to be removed. •During back washing the electrostatically removed material is removed and thus charge on filter material is replaced. | **1 M** |
| **c)** | **Define the term "residual chlorine". State its importance in disinfection.** | **04 M** |
| | **Definition:**<br>**Residual chlorine**: After a certain point of dosage any further addition of chlorine will appear as free residual chlorine. Simply it is extra chlorine remains in water after killing the bacteria.<br>**Importance:** When water completely purify after the treatment and then it is distributed through pipelines to different area of the town, then there is possibility of the pipes have the germs or bacteria stick to it then free residual chlorine in water used for killing bacteria in that pipe and quality of water is maintain for the consumer. | **02 M**<br>**02 M** |
| **d)** | **Enlist different types of valves used in water supply pipeline. Explain any one; with respect to the location and function"** | **04M** |
| | 1. Air valve<br>2. Sluice valve<br>3. Relief valve<br>4. Reflux valve<br>5. Scour valve<br>**1)Air valve:** some quantity of air is there in water it creates problem sometimes<br>**location:** for exit of such accumulated air, Air valve is provided at the summit of the water pipe and also provided close or above the hydraulic gradient<br>**function:** it allow the air to escape and flowing water without disturbance<br>**OR**<br>**2) Sluice valve**<br>It is also called as gate valve<br>Dividing the water pipes into suitable sections.<br>It is very useful in intermediate system<br>Location: placed at a distance of about 150m to 200m from joints.<br>Function: to control the flow of water.<br>**OR**<br>**3) Relief valve:** these are automatic cut off valves,<br>Pressure exeeds limit, valves operate automatically.<br>Load is adjusted to maximum pressure<br>Location: every point along the water pipe where pressure likely to be maximum<br>Function: it saves the particular section from bursting<br>**OR**<br>**4) Reflux valve:**<br>It is also known as check valve It allows the water to go in one direction only.<br>When water ceases it starts flowing back, and damage may crates.<br>Location: at the point where the water comes directly from the pump<br>Function: when pump fails, water will not flow back so it prevents from damaging.<br>**OR** | **02 M**<br>**1 M for Location**<br>**1 M For Function** |

| | | |
|---|---|---|
| | **5) Scour valve: T**hey are ordinary sluice valve and are operated with hand and close down immediately after clear water is seen passing through them.<br>Location: Located at dead ends and depression or lowest points in mains.<br>Function: To remove sand and silt deposited in pipe line. | |
| **e)** | **State different types of traps. Enlist four qualities of good trap**. | **04 M** |
| | **1) According to shape**<br>➢ P- trap<br>➢ Q- trap<br>➢ S- trap<br>**2) According to use**<br>➢ Gully trap<br>➢ Floor trap<br>➢ Intercepting trap<br>**Qualities of good trap**<br>➢ It should provide enough water seal **around 50mm** with large surface area.<br>➢ Interior should be smooth so that water flow should not obstructed.<br>➢ Good trap should achieve the self cleansing velocity.<br>➢ An assess door should be provided for cleaning the trap.<br>➢ It should be made up of non-adsorbent material. | **01 M**<br><br><br><br><br>**01 M**<br><br><br><br><br>**½ M each Any Four** |
| **f)** | **Enlist plumbing accessories required for plumbing of residential building.** | **04 M** |
| | **Plumbing accessories for residential building:**<br>**Pipes-** galvanized iron or PVC pipe<br>**Joints-:**Water taps, stopcock, Bends,tees,crosses, elbows, unions, caps, plug, sockets, nipples, flanges and back nuts<br>**Traps –** gully and floor traps are required<br>**Valves-**air or reflux or check valve or cutoff valves are required | <br>**01 M**<br>**01 M**<br><br>**01M**<br>**01 M** |

| Q .NO | SOLUTION | MARKS |
|---|---|---|
| Q.3 | **Attempt Any Four of the following:** | 16 M |
| a) | **Draw a neat labelled sketch of two pipe system of plumbing.** | 04 M |
| |  | 04 M |

**b) State permissible limit for potable water (As per IS 10500:1991) for total solids, pH, hardness, chlorides.** — **04 M**

**1M for Each**

| Sr.No. | Description | Desirable Limit | Permissible Limit |
|---|---|---|---|
| 1) | Total Solids | 500mg/l | 2000mg/l |
| 2) | pH | 6.5-8.5 | 6.5-8.5 |
| 3) | Hardness | 300mg/l | 600mg/l |
| 4) | Chlorides | 250mg/l | 1000mg/l |

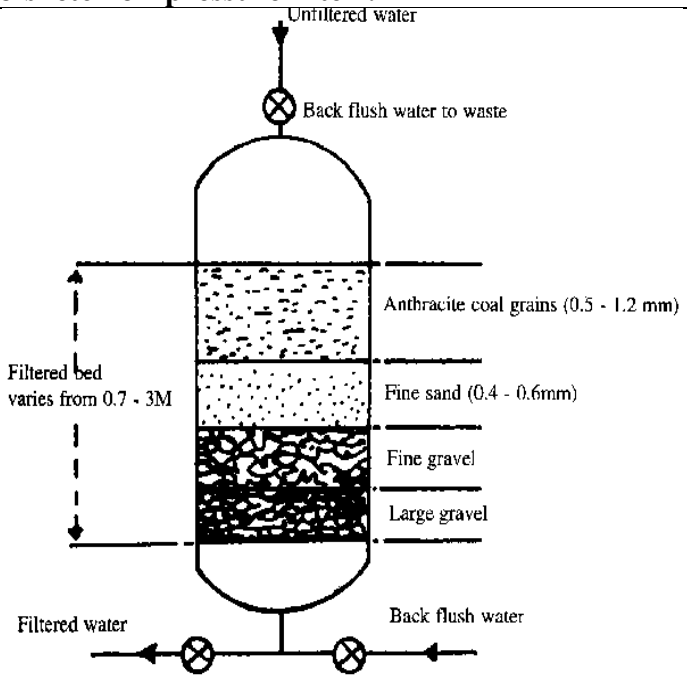
**c) Enlist four principles regarding design of building drainage.** — **04 M**

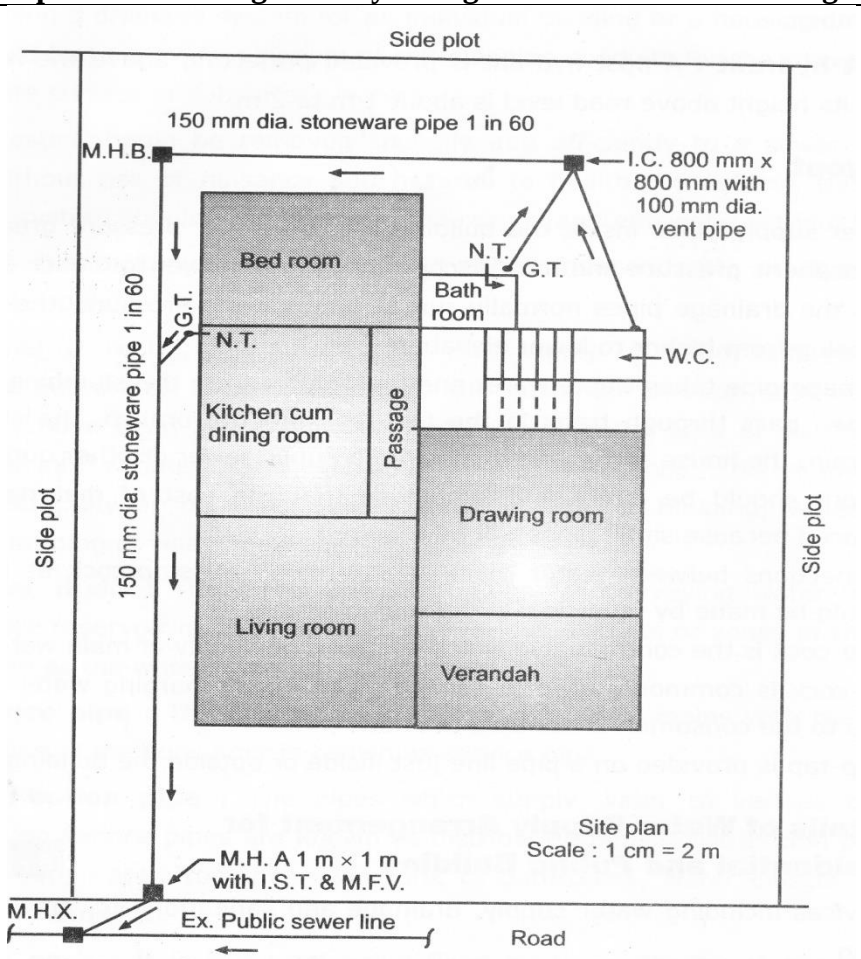
**01 M each Write any 4**

1. It is advisable to lay sewers by the side of building rather than below the building.
2. The drains should be laid straight between inspection chambers or manholes. All sharp bends and junctions should be avoided except through chambers or manholes.
3. The entire system should be properly ventilated from the starting point to the end point of disposal.
4. The house drain should be at higher level than public sewer otherwise there will be reverse flow from public sewer to house drain.
5. The house drainage should contain enough number of traps at suitable points for efficient functioning of it.
6. There should be intercepting trap between public sewer and house drain so that foul gases from public sewer could not enter in house drain.
7. The joints of sewers should be watertight and should be properly tested before putting drainage line in use.
8. The material of sewer should be standard and non absorbent and earth cushioning should be provided on sewer to protect it from external loads.
9. The sewage formed should be conveyed as early as possible after its formation.
10. The size of lateral sewers should be such that they will not overflow at the time of maximum discharge.

**d) Draw neat labeled sketch of 'pressure filter'.** — **04 M**

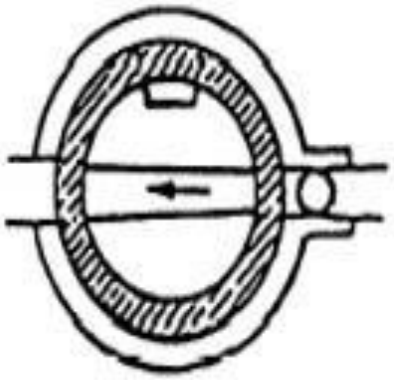
**04 M**



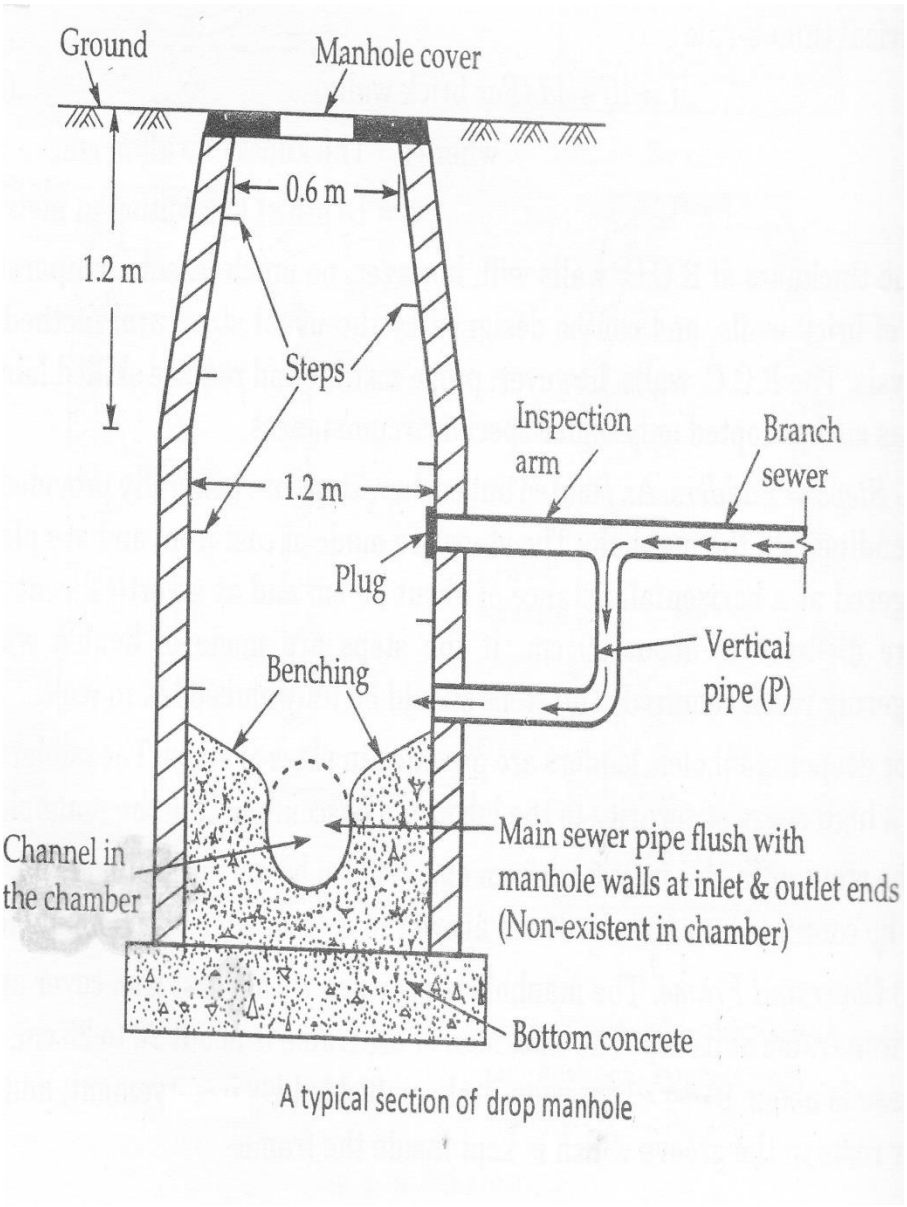
| | | |
|---|---|---|
| **e)** | **Define- (i) Self-Cleaning velocity**<br>**(ii) Non-Scouring velocity** | **04 M** |
| | **(i) Self-Cleaning velocity: -** The minimum velocity which will prevent the silting or deposition of particles of solid matter in sewers is known as self cleaning velocity. The gradient of sewer should be such that this velocity is developed at least once in a day preferably twice in a day. Usually it is 800mm to 900mm per second for normal sewage.<br>**(ii) Non-Scouring velocity: -** The maximum permissible velocity at which no scouring action by the solid particles of sewage on inside smooth surface of sewers will occur is known as non-scouring velocity. It mainly depends on material of sewer. | **02 M each** |
| **Q.4 (A)** | **Attempt any THREE of the following.** | **12M** |
| **(a)** | **Explain 'inspection chamber' with respect to necessity, location, size and shape.** | **04 M** |
| | **Necessity:** - Inspection chamber is a sanitary unit provided to inspect or identify the reason of blockage in case the system is blocked due to some reason.<br>It is constructed with thick concrete bed and brick or RCC walls. RCC slab is provided at the top in which a manhole or cleansing eye is provided. | **01 M** |
| | **Location**: - It is provided near the gully trap at a distance of about 2m to 3m and further connected to manhole through stoneware pipe. | **01 M** |
| | **Size**: - The size varies according to the diameter of drain or sewer, size of manhole or cleansing eye provided and functions of the chamber. | **01 M** |
| | **Shape**: - Inspection chamber are generally square or rectangular in shape. | **01 M** |
| **b)** | **Draw layout plan for building sanitary fittings for a residential building.** | **04 M** |
| |  | **04 M** |

| | | |
|---|---|---|
| **c)** | **Enlist various methods of distribution systems of water. State any two advantages and disadvantages of any one method.** | **04 M** |
| | **1) Gravity distribution system**<br>**2) Pumping distribution system**<br>**3) Combined gravity and pumping distribution system.**<br>**1. Gravity distribution system**<br>***Advantages:-***<br>1) This method is simple, reliable and economical<br>2) Water flows under gravity, therefore pumping is not required.<br>3) Less leakages and wastages.<br>4) Less maintenance.<br>5) This system requires small size of pipes.<br>***Disadvantages:*** **-**<br>1) It is not suitable if the source of water is not at sufficient elevation to cause flow under gravity.<br>2) This system cannot provide high pressure for fire demand.<br>**2. Pumping distribution system:-**<br>***Advantages:-***<br>1) Suitable for any type of topography.<br>2) Sufficient pressure is available in distribution system due to pumps.<br>3) Sufficient water is available with pressure for fire fighting.<br>***Disadvantages:-***<br>1) This system requires continuous power supply.<br>2) Sufficient water quantity is always required for pumping.<br>3) This system is not economical.<br>4) There are more losses and wastages.<br>5) This system requires more maintenance.<br>6) This system is not reliable in case of power failure as pumps will stop working.<br>**3. Combined gravity and pumping distribution system:-**<br>***Advantages:-***<br>1) This system is more reliable, economical and efficient.<br>2) Power failure does not affect the system.<br>3) Pumping is with constant speed.<br>4) Balance reserve is used in case of emergency or for fire demand.<br>***Disadvantages:*** - This system has no disadvantages. | **02 M**<br><br>**½ m for Each Adv. Write any Two**<br><br>**½ m for Each Adv. Write any Two** |

| d) | Draw a neat labeled sketch of drop manhole. | 04 M |
|---|---|---|




01 M




A typical section of drop manhole

03 M

**B) Attempt any ONE of the following.** **06 M**

**a) From the following census data calculate probable population in the year 1970, 1980, 1990.** **06 M**

| Year | 1930 | 1940 | 1950 | 1960 |
|---|---|---|---|---|
| Population | 10,000 | 14,000 | 19,000 | 25,000 |

**Use Geometrical increase method.**

| Year | Population | Increase in population | Percentage increase in population |
|---|---|---|---|
| 1930 | 10,000 | - | - |
| 1940 | 14,000 | 4,000 | (4000x100)/10000=40% |
| 1950 | 19,000 | 5,000 | (5000x100)/14000=35.71% |
| 1960 | 25,000 | 6,000 | (6000x100)/19000=31.58% |
| | **Total** | 15,000 | 107.29 |
| | **Average per decade** | 15,000/3=5000 | 107.29/3=35.76% |

**02 M**

Average percentage increase= r =35.76%

**01 M**

1) Population in year 1970 = $P\ (1 + \frac{r}{100})^n$

$= 25000\ (1 + \frac{35.763}{100})^1$

**Population in year 1970 = 33941 Peoples** **01 M**

2) Population in year 1980 = $P\ (1 + \frac{r}{100})^n$

$= 25000\ (1 + \frac{35.763}{100})^2$

**Population in year 1980 = 46079 Peoples** **01 M**

3) Population in year 1990 = $P\ (1 + \frac{r}{100})^n$

$= 25000\ (1 + \frac{35.763}{100})^3$

**Population in year 1990 = 62559 Peoples** **01 M**

**b) Define soil pipe, vent pipe, sullage, and waste pipe.** **06 M**

1. **Soil pipe: -** The pipe which receives and conveys discharge from soil fittings such as water closet, urinal etc. is called as soil pipe.
2. **Vent pipe**: - The pipe installed for ventilation is called vent pipe. This pipe prevents siphonic action in system and releases pressure of foul gases.
3. **Sullage**: - The term sullage is used to indicate the waste water from bathroom, kitchen, wash basin etc. As the organic matter is absent or negligible it does not create bad smell.
4. **Waste pipe**: - The pipe which carries discharge from sanitary fittings like kitchen sink, wash basin, bathroom etc. is called waste pipe.

**1 M for Each Def.**

**½ M each Example**

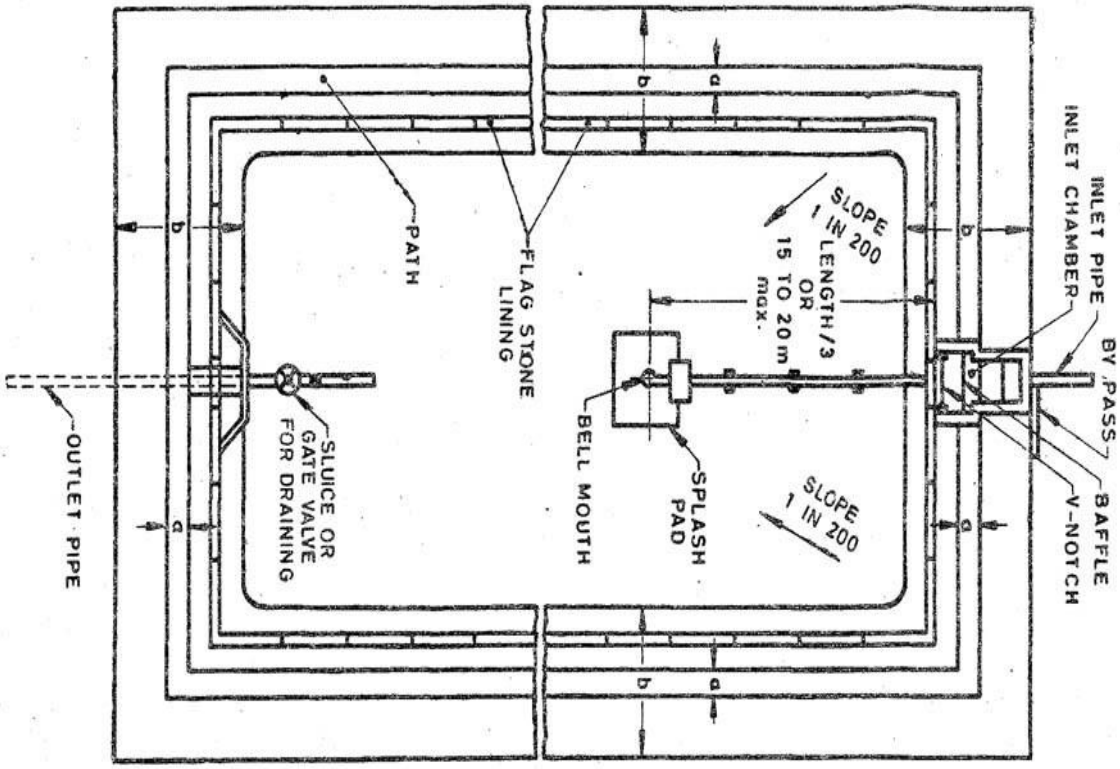
| Q .NO | SOLUTION | MARKS |
|---|---|---|
| Q5. | **Attempt ANY FOUR of following: ( 04x04 )** | **16 M** |
| (a) | **Design circular sewer using following data:**<br>**Population- 40,000**<br>**Total water supplied=300 lpcd.**<br>**Sewage to be carried=80%**<br>**Velocity=1 m/s** | **04 M** |
| | **Data:**<br>Population= 40,000<br>Rate of water supply = 300 lpcd<br>Average water supply = (in cumecs)<br>= 40000 X 300 /24 X 60 X 60 X 1000<br>= 0.138 Cumecs<br>Sewage to be carried = 80%<br>The average discharge of sewage produced = 0.8 X 0.138 = 0.1104 Cumecs<br>$Q = AV$<br>$0.1104 = \pi/4 \times d^2 \times V$<br>$d = 0.374$ m | **04 M** |
| (b) | **Enlist any four units of sewage treatment plant. State function of each.** | **04 M** |
| | **Units of sewage treatment plant:**<br><br>**1. Screening:** To remove the large floating and suspended matters.<br>**2. Grit Chamber:** To reduce the formation of heavy deposits in channel, pipes and conduits.<br>**3. Skimming Tank:** To remove oil, grease and fats from sewage.<br>**4. Sedimentation tank:** To separate the settable solids.<br>**5. Aeration Tank:** oxidizing carbonaceous biological matter, oxidizing nitrogenous matter: mainly ammonium and nitrogen in biological matter, removing nutrients (nitrogen and phosphorus)<br>**6) Chlorination:** is used to kill certain bacteria and other microbes in sewage as chlorine is highly toxic<br>**7) Sludge Digestion:** Sludge digestion is a biological process in which organic solids are decomposed into stable substances. Digestion reduces the total mass of solids, destroys pathogens, and makes it easier to dewater or dry the sludge.<br>**8) Trickling Filter:** A trickling filter , also called trickling biofilter, biofilter, biological filter and biological trickling filter , is a fixed-bed, biological reactor that operates under (mostly) aerobic conditions. Pre-settled wastewater is continuously 'trickled' or sprayed over the filter. | **1 marks Each Write Any Four** |

| (c) | Explain oxidation pond. | 04 M |
|---|---|---|

**02 M**

- It is low cost, simple and artificial pond, 1-2 m deep where sewage cab is retained for sufficient time to satisfy BOD.
- In shallow plants, algae supply the additional oxygen through the process of photosynthesis under aerobic conditions.
- If the depth is 3-5m decomposition takes place under anaerobic condition at lower depth.
- Aerobic bacteria use oxygen and convert the organic matter into the stable compound. An alga consumes $CO_2$ and liberates oxygen in sewage.
- The combined action is called as Bacterial Algal Symbiosis.
- In facultative ponds, the upper layers are under aerobic compositions and lower layers are under anaerobic conditions. In the middle portion, the algae may release oxygen to upper layers. From settled organic load methane, ammonia, $CO_2$etc may be released.
- Various processes like sedimentation, oxidation, digestion photosynthesis, gas exchange, evaporation and seepage takes place in an oxidation pond.
- Oxidation ponds are mutually used to treat the settled sludge.

**02 M Fig**




*a* = Top width of the bund.
*b* = Bottom width of the bund.

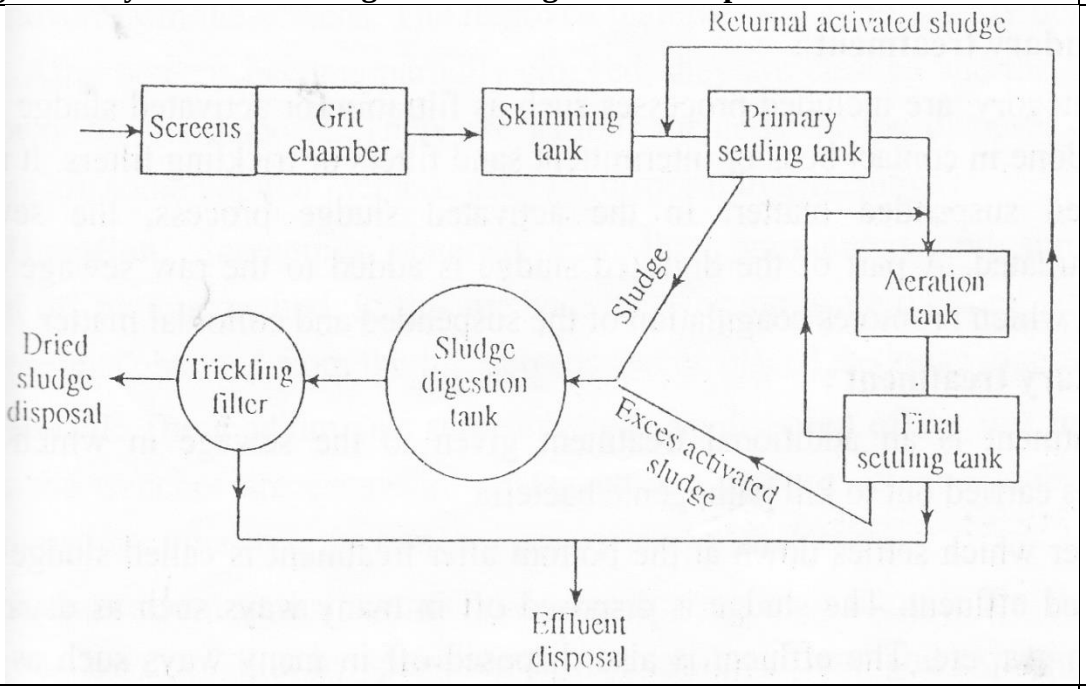
| Q .NO | SOLUTION | MARKS |
|---|---|---|
| (d) | **State MPCB norms for discharge of treated sewage.** | 04 M |

MPCB norms for discharge of treated sewage:

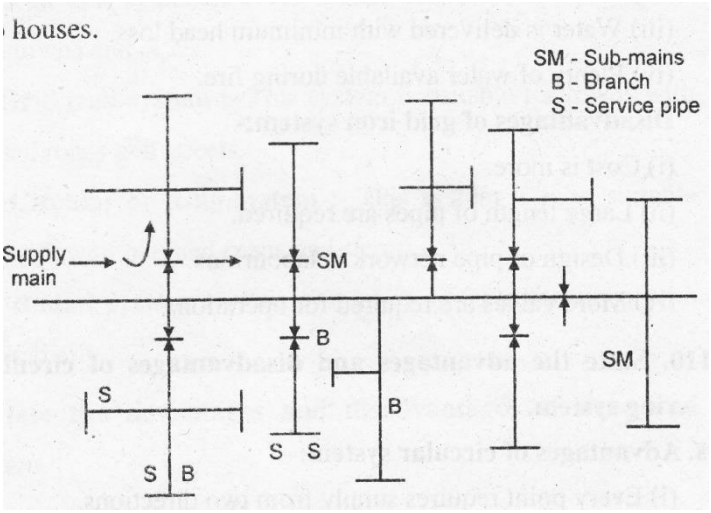
| Characteristics of the effluent | Tolerance limit for sewage effluent s discharged into inland surface water | Tolerance limits for industrial effluents discharged into | | Tolerance limits for inland surface water, when used as raw for public water for supplies and bathing ghats |
|---|---|---|---|---|
| | | Inland surface water | Public sewers | |
| **BOD** | 20 | 30 | 500 | 3 |
| **COD** | - | 250 | - | - |
| **pH** | - | 5.5-9.0 | 5.5-9.0 | 6.0-9.0 |
| **Total Suspended Solids** | 30 | 100 | 600 | - |
| **Temperature $^{o}$c** | - | 40 | 45 | |
| **Oil and Grease** | - | 10 | 100 | 0.1 |
| **Phenolic compounds** | - | 1.0 | 5 | 0.005 |
| **Cyanides,mg/l** | - | 0.2 | 2.0 | 0.01 |
| **Sulphides ,mg/l** | - | 2.0 | - | |
| **Fluorides,mg/l** | - | 2.0 | - | 1.5 |
| **Total residual chlorine,mg/l** | - | 1.0 | - | |
| **Insecticides ,mg/l** | - | 0 | - | 0 |
| **Arsenic** | - | 0.2 | - | 0.2 |
| **Cadmium ,mg/l** | - | 2.0 | - | - |
| **Chromium ,mg/l** | - | 0.1 | 2.0 | 0.05 |
| **Sulphates, mg/l** | - | - | | 1000 |
| **Copper,mg/l** | - | 3.0 | 3.0 | - |
| **lead,mg/l** | - | 0.1 | 1.0 | 0.1 |
| **Mercury,mg/l** | - | 0.01 | - | - |
| **Nickel,mg/l** | - | 3.0 | 2 | - |
| **Zinc,mg/l** | - | 5.0 | 15.0 | - |
| **Chlorides ,mg/l** | - | - | 600 | 600 |

**½ M for each Write any Eight**

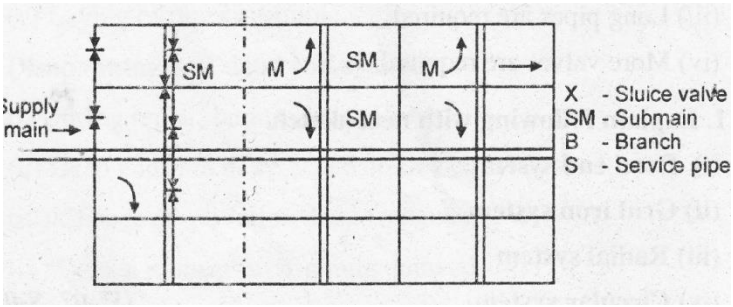
| Q .NO | SOLUTION | MARKS |
|---|---|---|
| (e) | **Explain the concept of rain water harvesting with respect to necessity and methods.** | **04 M** |
| | Rain water harvesting is a system by which rainwater that collects on the roof and area around the building is directed into open wells through a filtered tank or into a percolating chamber, built specially for this purpose. Rain water is collected directly or recharged into the ground to improve ground water storage.<br>**Necessity of Rain Water Harvesting:**<br>➢ Increase ground water storage<br>➢ Prevent wastage of water by arresting runoff<br>➢ Safeguard and sustain existing water table<br>➢ Improve water quality<br>➢ Prevent soil erosion<br>➢ Mitigates flood<br>➢ Prevent sea water intrusion and salination of ground water<br>➢ To meet the demand for future generation.<br>**Method of Rain Water Harvesting:**<br>i) Roof top method<br>ii) Recharge pit method<br>iii) Percolation pond method<br>iv) Recharge trench method<br>v) Check dam method | **01 M**<br>**02 M**<br>**02 M** |
| (f) | **Explain activated sludge process.** | **04 M** |
| | • Raw sewage from a primary settling tank(D.T.1 to 1.5 hrs) enter into an aeration tank<br>• The raw sewage is mixed with 20% to 30% of activated sludge (return sludge) in aeration tank, the mixture is known as mixture liquor.<br>• The mixture liquor is aerated and agitated in the tank for about 4 to 8hrs.the micro-organism oxidize organic matter in the presence of abundant quantity of oxygen.<br>• Sewage is allowed to settle in secondary settling tank. This settled sludge has undergone aeration and has active microorganism, so some portion of this active sludge is re-circulated into the aeration tank for seeding the raw sewage. Excess quantity of sludge is treated and disposed off.<br>• The effluent from SST is disposed off. A portion of effluent is mixed in raw sewage before sending it to PST. | **04 M** |

| Q .NO | SOLUTION | MARKS |
|---|---|---|
| Q6. | **Attempt ANY FOUR of following: ( 04 x 04 )** | **16 M** |
| (a) | **Draw general layout and flow diagram of sewage treatment plant** | **04 M** |
| |  | **04 M** |
| (b) | **Define BOD and COD. State its significance in treatment of sewage.** | **04 M** |
| | **Define BOD-:** BOD is defined as the amount of oxygen consumed by the micro- organisms for biochemical oxidation of the decomposable matter at specific temperature within the specific time.<br>**Significance-:**<br>i) Only the biodegradable organics are measured.<br>ii) The relatively long period of time required to obtain test result.<br>**Define COD-:** It is defined as the amount of oxygen required to oxidize matter by strong oxidizing agent under acidic conditions.<br>**Significance-:**<br>i) To measure the content of organic matter, biodegradable as well as non-bio-degradable matter COD test is carried out.<br>ii) The COD test can be carried out to measure organic matter present in industrial waste having toxic compound likely to interfere with the biological life. | **01 M**<br><br>**01 M**<br><br>**01 M**<br><br>**01 M** |
| (c) | **Enlist different methods of layout of distribution of water. Explain any one in detail.** | **04 M** |
| | i) Dead end system<br>ii) Grid iron system<br>iii) Circular system<br>iv) Radial system. | **½ M for each** |

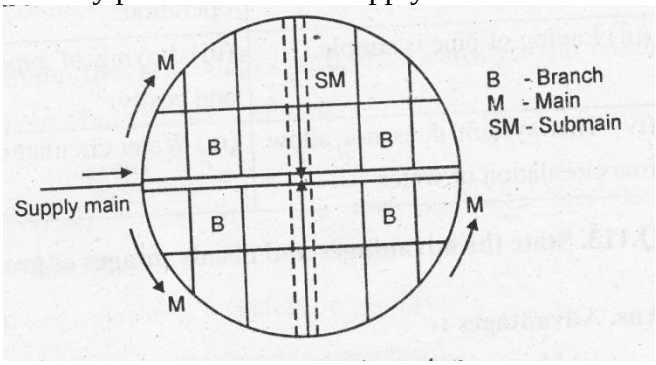
| Q .NO | SOLUTION | MARKS |
|---|---|---|
| (C) Cont… | i) **Dead end system:** In this system one main start from service reservoir along the main road. Sub main are connected to the main in both directions along other roads which meet the main road. This system is suitable for irregular developed towns and cities. | **02 Marks for Explanation and fig. Write ANY ONE** |

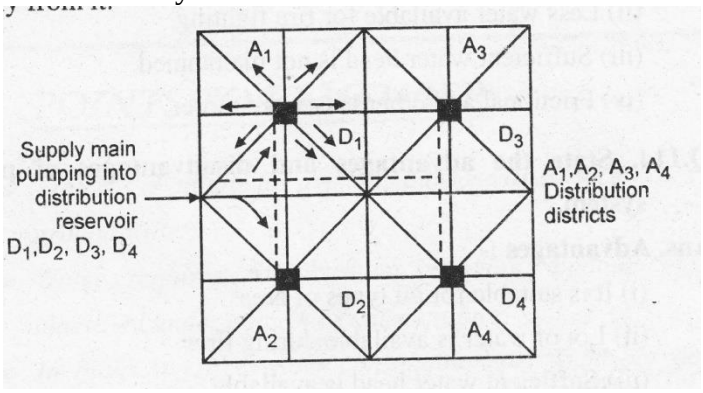



**Grid iron system:** This is improvement over dead end system. All the dead ends are interconnected to each other and water circulates freely. Main line is laid along main roads and streets from these sub main and branches are taken out and are interconnected. This system removes all disadvantages of dead end system




ii) **Circular system:** In this system each locality is divided into circular or square blocks and the water mains are laid around all the four sides of round or circle. The sub mains and branches are taken off from the boundary mains and are connected. Thus every point receives its supply from two directions.



| Q .NO | SOLUTION | MARKS |
|---|---|---|
| (C) Cont… | i) **Radial System:** This is reverse of ring system and water flows towards outer periphery from one point. The entire city is divided into various zones and one reservoir is provided for each zone, which is placed in the centre of zone. The water lines are laid radially from it.   | |
| (d) | **Explain in brief testing and maintenance of sewers.** | 04 M |
| | **i)Water Test**<br>➢ This test is carried out for sewer lines between two manholes.<br>➢ Plugging is done by rubber plug at its lower end.<br>➢ Rubber plug is connected with air blown.<br>➢ The upper end of sewer is plugged with a connection to the funnel.<br>➢ The sewer is filled with water and to maintain the required head, water level in the funnel is kept 2 m above the upper end.<br>➢ This head varies with the material of sewer.<br>➢ In case of cast iron sewer, the head should be at 9m.<br>➢ The acceptable loss or head loss should not exceed 2 litres/cm of length of the sewer.<br>➢ To perform this test sufficient amount of water should be available.<br>**ii) Air Test**<br>➢ When sufficient amount of water is not available, then air test is to be carried out.<br>➢ Air is pumped into the pipeline, usually via a hand-pump with a control valve, until the reading on the manometer is around 125-150mm.<br>➢ The set-up is then left for 5-10 minutes to allow for temperature stabilisation within the pipe before the pressure is reduced to exactly 100mm on the manometer scale.<br>➢ The manometer is then monitored for a period of 5 minutes; the level of water in the manometer should not fall below the 75mm mark during this period.<br>➢ This is deemed to be a 'pass' and the pipeline is declared satisfactory and can be backfilled.<br>➢ However, if the level in the manometer does fall below the 75mm mark, then the equipment should be checked and cleaned and the pipeline examined for leaks or defects**.**<br>➢ If any problems are identified, they should be rectified before re-testing. | **2 M for Any one Test** |

| Q .NO | SOLUTION | MARKS |
|---|---|---|
| | **Maintenance of sewers consists mainly the removal of prevention of stoppages, cleaning of sewers and repairs works. Following works are generally done for maintaining sewers:**<br>➢ **Inspection:** Examination of sewers, rate of flow, silting, amount of clogging, Ventilation. Etc.<br>➢ **Cleaning and flushing:** Cleaning and flushing of sewers are done through manhole by using flexible rod, mechanical tools and pill float.<br>➢ **Cleaning of catch pits:** Sand, silt, debris, etc. deposited in sewer these can be cleaned after every monsoon.<br>➢ **Proper connections:** All connections and joints are properly maintained so that leakage should be avoided.<br>➢ **Periodic repairs:** Theperiodic repairs and maintenance programme should be run for the maintenance of sewer. | **02 M** |
| **(e)** | **Enlist various pipe materials used for conveyance of water.** | **04 M** |
| | The various types of pipe materials used for conveyance of water are as follows:<br>➢ Cast iron pipes<br>➢ Wrought iron pipes<br>➢ Steel Pipes<br>➢ Concrete Pipes<br>➢ Wooden Pipes<br>➢ Vitrified pipes<br>➢ Copper and lead pipes<br>➢ Asbestos cement pipes<br>➢ Cement lined cast iron pipes | **½ m for each** |