



SUMMER-16 EXAMINATION
Model Answer

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.



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Q No.	Answer	Marks	Total marks
1A	Attempt any three		12
a)	Air Pollution: Air pollution is the introduction of particulates, biological molecules, or other harmful materials into Earth's atmosphere, causing disease, death to humans, damage to other living organisms such as food crops, or the natural or built environment. Classification of Air Pollutant: Gaseous pollutants :- SO _x , NO _x , CO Particulate matter :- Cement dust, metal dust Fumes :- Acid fumes, Welding fumes Smoke : Smoke after burning fuel, Smoke after burning waste	2 2	4
b)	Types of water pollutants 1. Oxygen demanding waste: Organic waste, sewage, food industry waste, distillery. 2. Disease causing waste : Pathogens 3. Synthetic organic compounds: Industrial waste from petrochemical Plant. 4. Plant nutrients: Fertilizer from farms. 5. Inorganic chemicals: Waste from fertilizer, acid and chloro alkali Industry. 6. Thermal discharge: condenser water from thermal power plant. 7. Oil: oil from industrial equipment, crude oil tankers.	4	4
c)	Pollutants from urea plant <ul style="list-style-type: none">• Oil and grease• Ammonia• Fluorides• Phosphate	1 mark each for any four	4



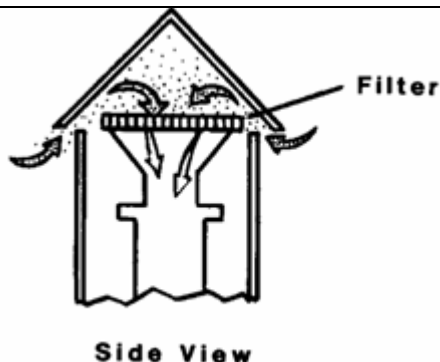
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	<ul style="list-style-type: none">• NaOH• Arsenic		
d)	<p>Characteristics of solid waste</p> <p>The major physical characteristics measured in waste are: (1) density, (2) size distribution of components, and (3) moisture content. Other characteristics which may be used in making decision about solid waste management are: (1) colour, (2) voids, (3) shape of components, (4) optical property, (5) magnetic properties, and (6) electric properties. Optical property can be used to segregate opaque materials from transparent substances which would predominately contain glass and plastic. Moisture content is essential for leachate calculation and composting. Density is used to assess volume of transportation vehicle and size of the disposal facility. Shape can be used for segregation as flaky substance will behave differently compared to non-flaky substance. Important chemical properties measured for solid waste are: (1) moisture (water content can change chemical and physical properties), (2) volatile matter, (3) ash, (4) fixed carbon, (5) fusing point of ash, (6) calorific value, (7) percent of carbon, hydrogen, oxygen, sulphur and ash. Proximate analysis of waste aims to determine moisture, volatile matter, ash and fixed carbon. Ultimate analysis of waste aims to analyse percent of carbon, hydrogen, oxygen, sulphur and ash. Solid waste production is a function of land use as well as its composition is inversely proportional to the possible soil damage and bacterial contamination of the environment Wet waste will host more bacteria compared to dry waste.</p>	1 mark each for any four characteristics	4
1B	Attempt any one		6
a)	High Volume Sampler		6



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The sampler uses a continuous duty blower to suck in an air stream. When fitted with a particle size classifier, it separates particles greater than $10\mu\text{m}$ size from the air stream. The air stream is then passed through a filter paper to collect particles lesser than $10\mu\text{m}$ size (PM₁₀). Gravimetric measurements yield values of suspended particulate matter (SPM), as the sum of the two fractions, and PM 10, the material retained on the filter paper. The sampler can also be used to sample gaseous pollutants. A stream of unfiltered air is bubbled through a reagent, which either reacts chemically with the gas of interest or into which the gas is dissolved. Wet chemical techniques are then used to measure the concentration of the gas.

4

Procedure:

1. Clean the apparatus thoroughly.
2. Weigh the clean and dry filter paper using electronic balance and note its initial weight (W_1).
3. Filter paper should not be folded.
4. Open the dome and place filter paper on gasket.
5. Tightly close dome to avoid any air leakage.
6. Place high volume sampler at suitable location in open space.

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	<p>7. Start blower of high volume sampler and adjust flow rate between 1 to 1.5 m³/min.</p> <p>8. Note down the value of initial flow rate (Q₁).</p> <p>9. Set the time for 24 hours.</p> <p>10. After 24 hrs note down final flow rate (Q₂).</p> <p>11. Stop the blower and open the dome.</p> <p>12. Remove filter paper carefully and dry it.</p> <p>13. Weigh the filter paper and note down final weight (W₂).</p> <p>Total volume of air taken for sample $V = [(Q_1 + Q_2)/2] \times T$</p> <p>Where V = volume of air sample (m³) Q₁ = Initial flow rate m³/min Q₂ = Final flow rate m³/min T = Sampling time in min</p> <p>Concentration of RSPM in µg/m³ $= [(W_2 - W_1) \times 10^6] / V$</p>		
b)	<p>Solid waste collection from house to house :</p> <p>i) Curbside collection, or Kerbside collection, is a service provided to households, typically in urban and suburban areas, of removing household waste. It is usually accomplished by personnel using purpose built vehicles to pick up household waste in containers acceptable to or prescribed by the municipality. Kerbside collection is today often referred to as a strategy of local authorities to collect</p>	3	6

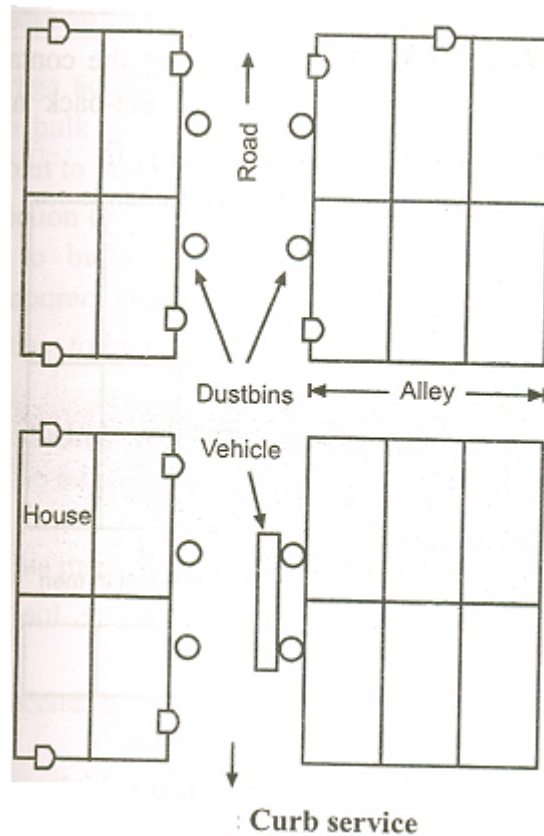


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recyclable items from the consumer. Kerbside collection is considered a low-risk strategy to reduce waste volumes and increase recycling rates. Materials are typically collected in large bins, coloured bags, or small open plastic tubs, specifically designated for content.

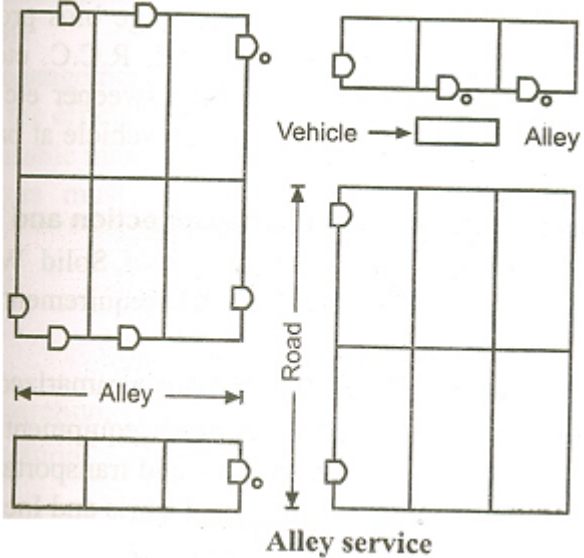
- ii) **Alley service:** this method is similar to the previous one, except that the containers are placed at the alley line instead of curb.

3



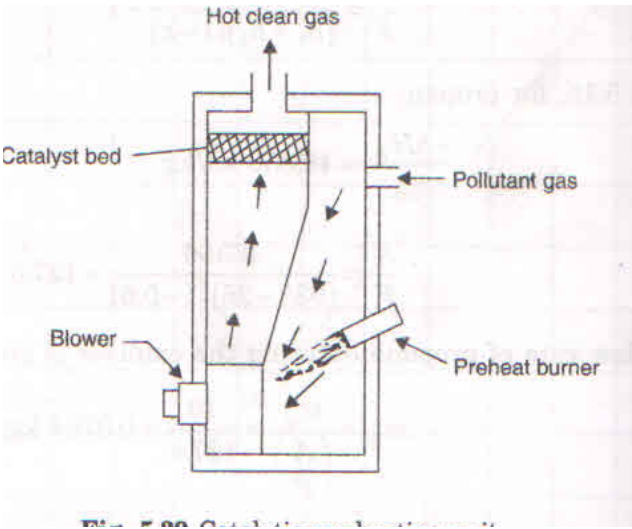


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2	Attempt any four		16
a)	<p>Catalytic Incinerator</p> <p>The catalysts used for effective pollution control are the precious metals, primarily platinum and palladium or their alloys. These are arranged in such a way as to provide the maximum possible surface area for contact with the gas.</p> <p>The catalyst is coated onto suitable elements such as metal ribbons, ceramic rods or alumina pellets. These elements are then packed into the Catalyst bed. A catalytic combustion unit consists of a reaction vessel or converter in which the catalyst is arranged in single or multiple fixed beds preceded by a preheat section, if necessary.</p> <p>In the preheat section, only the gas stream is heated to the temperature required to support catalytic combustion. The preheated gas is then passed through the catalyst bed where the combustion occurs. To maintain the catalyst in an active state and to achieve complete combustion</p>	02	04



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	<p>about 1% excess oxygen is required.</p>  <p>The diagram illustrates a catalytic converter. It consists of a vertical cylindrical chamber. At the bottom left, a blower draws air into the chamber. At the bottom right, a preheat burner provides heat. Pollutant gas enters from the right side. The gas flows upwards through a catalyst bed, which is represented by a hatched rectangular area. After passing through the catalyst bed, the gas exits from the top as hot clean gas.</p>	02	
b)	<p>Activated sludge process</p> <p>Working</p> <p>A basic activated sludge process consists of several interrelated components:</p> <ul style="list-style-type: none">• An aeration tank where the biological reactions occur• An aeration source that provides oxygen and mixing• A tank, known as the clarifier, where the solids settle and are separated from treated wastewater• A means of collecting the solids either to return them to the aeration tank, (return activated sludge [RAS]), or to remove them from the process (waste activated sludge [WAS]). <p>Aerobic bacteria thrive as they travel through the aeration tank. They multiply rapidly with sufficient food and oxygen. By the time the waste reaches the end of the tank (between four to eight hours), the bacteria has used most of the organic matter to produce new cells. The organisms settle to the bottom of the clarifier tank, separating from the clearer water. This sludge is</p>	04	4



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	pumped back to the aeration tank where it is mixed with the incoming wastewater or removed from the system as excess, a process called wasting. The relatively clear liquid above the sludge, the supernatant, is sent on for further treatment as required		
c)	BOD and COD BOD: - It is the amount of oxygen required to degrade organic waste present in water by purely biological means. The biological oxygen demand, ie, BOD in wastewater, is a measure of the quantity of bio-organic substances in wastewater. These can be in the form of fat, oils, carbohydrates and proteins. BOD also helps to determine the quantum of organic chemicals contained in wastewater that are synthetic and biodegradable. COD: - It is the amount of oxygen required to degrade organic waste present in water by purely chemical means. COD can help gauge the quantum of both biodegradable and non biodegradable organics. It is quick method to determine strength of waste in water.	1 1 1	04
d)	3R principle Reuse: In today's world use and through materials is increasing and hence solid waste. Instead of throwing that material or item if it is used again, energy and environment can be saved. Solid waste generation also will be reduced. In industry various boxes, cans, pallets etc are used for material handling. These can be used again for same purpose. e.g. Catalyst drums can be used again to fill catalyst. Recycle : Recycling is a process to change materials (waste) into new products to prevent waste of potentially useful materials, reduce the consumption of	1 2	4



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	<p>fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from landfilling) by reducing the need for "conventional" waste disposal, and lower greenhouse gas emissions as compared to plastic production. Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, and Recycle" waste hierarchy. Recyclable materials include many kinds of glass, paper, metal, plastic, textiles, and electronics. In the strictest sense, recycling of a material would produce a fresh supply of the same material-for example, used office paper would be converted into new office paper, or used foamed polystyrene into new polystyrene.</p> <p>e.g. Plastic water bottles can be recycled to get plastic again.</p> <p>Reduce: When you avoid making garbage in the first place, you don't have to worry about disposing of waste or recycling it later. Changing your habits is the key - think about ways you can reduce your waste when you shop, work and play. There's a ton of ways for you to reduce waste, save yourself some time and money, and be good to the Earth at the same time. Buy products in bulk. Larger, economy-size products or ones in concentrated form use less packaging and usually cost less per ounce.</p> <p>e.g. Unnecessary use of plastic and paper can be avoided in packing.</p>	1	
e)	<p>Need of ISO14001:</p> <ul style="list-style-type: none">i) Environmental improvementsii) Regulatory complianceiii) Improvement of corporate imageiv) Cost containment & cost savingv) Competitive advantagevi) Opening of international market & partners	1 mark each for any four	4



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	vii) Improvement in employee awareness about environment viii) An ethical or social commitment		
3	Attempt any four		16
3 a)	Grab Sampling method for gaseous pollutant: In grab sampling the sample is collected by filling an evacuated flask or an inflatable bag. Plastic bags have been widely used for grab sampling and for storage before analysis. Bag sampling is subject to losses caused by moisture condensation or diffusion through the walls of the bag. The losses can be minimized by performing the analysis immediately following collection. Grab samples may be taken using rigid wall containers made from glass or stainless steel. These containers are first evacuated and then filled by allowing air to enter. Alternatively, a container may be filled with water and then used as a collector simply by draining away the water which is replaced by the air sample.	04	4
b)	Effect of air pollution on human health: 1) Sulfur dioxide (SO₂) : i) SO ₂ is an irritant gas which can easily get oxidized to sulfur trioxide and in the presence of water, these can form sulfurous and sulfuric acid . ii) The health problems related to the mucous membrane and respiratory tract are due to sulfate aerosols. iii) Chronic effects of SO ₂ include increased probabilities of bronchitis, "colds" of long duration and suppression of immune system. 2) Hydrocarbons : iv) The health effects of hydrocarbons have been noted in occupational exposures to tetra methyl lead, benzene, etc. v) Inhaling formaldehyde can cause irritation.	Any 4Points maybe given 1 mark each	4



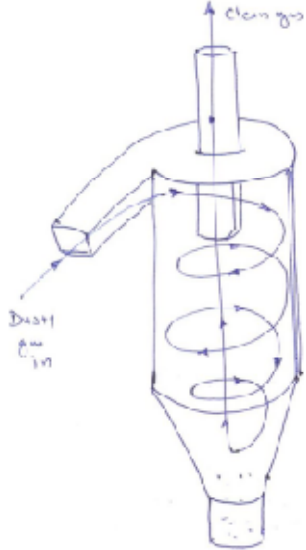
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	<p>vi) It is a major contributor to eye and respiratory irritation caused by photochemical smog.</p> <p>3) Carbon monoxide :</p> <p>vii) Carbon monoxide has a great affinity for the hemoglobin in the blood and combines with blood to form carboxyhemoglobin. This reduces the ability of hemoglobin to carry oxygen to the body tissues.</p> <p>4) Oxide of Nitrogen:</p> <p>viii) NO reduces the oxygen carrying capacity of blood.</p>		
c)	<p>Physical Characteristics of waste water: i) Temperature ii) Odor iii) Color iv) Total dissolved solids v) Turbidity</p> <p>Chemical Characteristics of waste water: i) Chemical oxygen demand(COD) ii) pH iii) Acidity or alkalinity iv) hardness v) Total carbon vi) Chlorine demand</p>	02 02	4
d)	<p>Working of cyclone separator</p> <p>A dust laden gas enters in a cyclone separator takes spiral motion. It utilizes a centrifugal force generated by spinning gas stream to separate particle matter from the gas. The centrifugal force on a particles in spinning gas stream is much greater than gravity, there for it is effective in removing small particles.</p> <p>The gas spirals downwards to the bottom of the cone and at, and at the bottom the gas flow reverses to form an inner vortex which leaves through the outlet pipe. Cyclone separator is used to separate gas-solid, gas-liquid in Cement industry ,Oil refinery, Petrochemical Plant, Power plants, and Metallurgical Industry etc.</p>	02	4



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	 <p>Cyclone Separator</p>	02	
e)	<p>Role of pollution control board :-</p> <ol style="list-style-type: none">1. To promote cleanliness of streams and wells in different areas of the States through prevention, control and abatement of water pollution;2. To improve the quality of air and to prevent, control or abate air pollution in the country;3. Advise the Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air;4. Plan and cause to be executed a nation-wide programme for the prevention, control or abatement of water and air pollution;5. Plan and organise training of persons engaged in programmes for prevention, control or abatement of water and air pollution;6. Organise through mass media, a comprehensive mass awareness programme on prevention, control or abatement of water and air pollution;7. Collect, compile and publish technical and statistical data relating to water	1 mark each for any four	4



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	<p>and air pollution and the measures devised for their effective prevention, control and abatement;</p> <p>8. Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts;</p> <p>9. Disseminate information in respect of matters relating to water and air pollution and their prevention and control;</p> <p>10. Lay down, modify or annul, in consultation with the State Government concerned, the standards for stream or well, and lay down standards for quality of air;</p> <p>11. Establish or recognize laboratories to enable the Board to perform;</p> <p>12. Perform such other functions as and when prescribed by the Government of India.</p> <p>13. To issue directions to any industry, local bodies, or other authority for violation of the notified general emission and effluent standards, and rules relating to hazardous waste, bio-medical waste, hazardous chemicals, industrial solid waste, municipal solid waste including plastic waste under the Environment (Protection) Rules, 1986.</p>		
f)	<p>Methods used for Wastewater sampling are, i) grab sampling ii) composite sampling.</p> <p>Grab sampling is just what it sounds like; all of the test material is collected at one time. As such, a grab sample reflects performance only at the point in time that the sample was collected, and then only if the sample was properly collected.</p> <p>OR</p> <p>Composite sampling consists of a collection of numerous individual discrete</p>	01	4

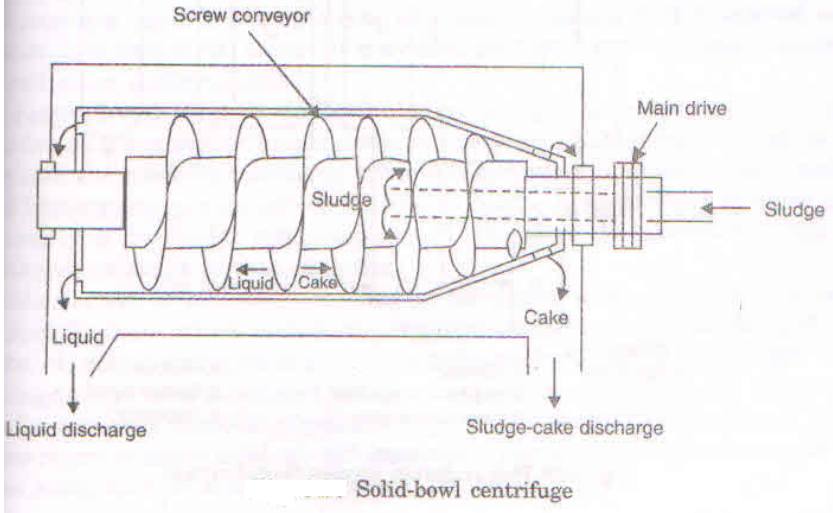
Explanation of any one with example may given 03mark

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	<p>samples taken at regular intervals over a period of time, usually 24 hours. The material being sampled is collected in a common container over the sampling period. The analysis of this material, collected over a period of time, will therefore represent the average performance of a wastewater treatment plant during the collection period.</p> <p>When wastewater flow and composition are relatively uniform grab samples of a fixed volume can be manually taken at given time intervals and composite sample obtained. If the flow rate varies the volume of the grab sample collected is proportional to the flow.</p>		
4A	Attempt any three		12
4A a)	<p>Sludge dewatering is accomplished by mechanical methods, the most common being centrifugation and filtration, which includes pressure filtration and vacuum filtration. In centrifugation, conditioned sludge is added to a rotating bowl that separates the sludge into a cake and a dilute stream. The solid cake is transported within the bowl and is removed by a screw conveyor at one end of the bowl the liquid is removed at the opposite end. Centrifugation is a compact method which requires careful control of process variables.</p> <p>Explanation of any one method (Filtration, using plate and frame pressure filters or rotary drum vacuum filter or drying beds) (02 mark) with neat sketch (02mark) may give 04 mark</p>	02 Mark	04

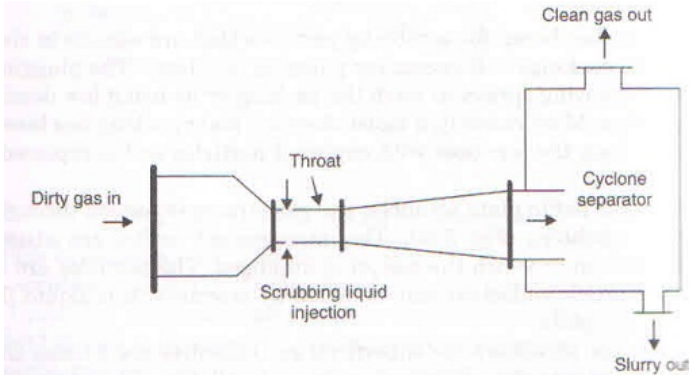


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		02Mark	
b)	<p>Preliminary treatment consists of screening , comminuting and grit removal.</p> <p>Large quantities of floating rubbish such as cans, cloth, and wood and other larger objects present in waste water are usually removed by metalbars, acting like strainers as the waste water moves beneath them in an open channel.</p> <p>Removal of gross solids is generally accomplished by passing wastewater through mixed or moving screens. The modern mechanical screens cum filters include rotary, self cleaning, gravity type units and circular overhead fed vibratory units which are effective in reducing the suspended solid and BOD.</p> <p>Grit is removed in the early stages of treatment in grit channels or tanks. Grit, being heavier than organic solids, can be separated from organic solids by careful regulation of the flow velocity in the grit tanks.</p> <p>If the waste water contains appreciable quantities of oil and grease, then it is advisable to remove as much of these as possible, in the preliminary treatment itself to avoid adverse effects on the rest</p>	02 1 mark each for any two Explanation of any one may given 02 mark	04



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	<p>of plant.</p> <p>This is achieved by passing the waste water through skimming tanks where oil and grease are skimmed off.</p>		
c)	<p>Working of venturi scrubber: The high performance of the venturi scrubbers is achieved by accelerating the gas stream to very high velocities, of the order of 60-120m/s. The high speed action atomizes the feed liquid, generally introduced in a uniform fashion across the throat through several low pressure spray nozzles directed inward as shown in fig.</p> <p>The droplet accelerates in the throat section and due to the velocity difference between the particles and the droplets the particles are impacted against the slow moving droplets. This acceleration of the droplets is not likely to be completed at the end of the throat, so that particle collection continues to some extent into the diverging section of the venturi. The gas-liquid mixture is then directed to a separation device such as a cyclone separator where the droplets carrying the particulate matter are separated from the gas stream.</p> <p>The mechanisms affecting the collection of particulates in the venturi scrubber are inertial impaction, diffusion, electrostatic phenomenon and condensation and agglomeration.</p>	02	04
	 <p>Venturi scrubber followed to cyclone separator</p>	02	



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d)	<p>The necessity of environmental audit for any chemical plant:</p> <p>i) It helps in assessing whether the existing environmental practices being followed are satisfactory and whether the environmental protection regulations are complied with.</p> <p>ii) It provides an opportunity for comprehensive review of environmental policies, management systems, organizations and practices and to assess whether introduction of new innovative practices are necessary to comply with the stringent regulations from time to time.</p> <p>iii) It protects against possible penalties or regulatory risk.</p> <p>iv) It contributes its modest share towards sustainable development and gives due credit for environmental management.</p> <p>v) It provides an up to date environmental data base which may be useful in emergencies and also while making decision on plant modifications.</p>	04	04
4B	Attempt any one		6
4 B a)	<p>The necessity of recovery of chemical from black liquor in pulp and paper industry:</p> <p>i) The spent cooking liquor commonly called black liquor is treated to recover its chemical content for reuse and its organic content as heat.</p> <p>ii) The dark color of the effluent is due to the lignin compounds which are not easily biodegradable and hence it imparts persistent color to the receiving water streams and inhibits photosynthesis and other natural self-purification process of the water streams.</p> <p>iii) The immediate oxygen demand of the effluent brings about depletion of oxygen of the receiving stream create adverse effects to aquatic life.</p> <p>iv) The chemicals present in the effluent, e.g. sulfites, phenols, free chlorine, methyl mercaptan are harmful to fauna and flora of the receiving</p>	02 mark each for any three points	6



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	humanvalues such as service to society, non-material enrichment.		
5	Attempt any Four		16
a)	Electrostatic Precipitator Working: The most basic precipitator contains a row of thin vertical wires, and followed by a stack of large flat metal plates oriented vertically, with the plates typically spaced about 1 cm to 18 cm apart, depending on the application. In cylindrical design a wire is hanged with weight inside a cylinder. The air or gas stream flows horizontally through the spaces between the wires, and then passes through the stack of plates. A negative voltage of several thousand volts is applied between wire and plate. If the applied voltage is high enough an electric (corona) discharge ionizes the gas around the electrodes. Negative ions flow to the plates and charge the gas flow particles. The ionized particles, following the negative electric field created by the power supply, move to the grounded plates.	2	4
		2	



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<p>b)</p>	<p>Sources of biomedical waste</p> <ul style="list-style-type: none"> • Hospital • Pathological labs • Research centers <p>Biomedical waste treatment by thermal process</p> <p>Thermal process use heat to decontaminate or destroy medical waste. Most microorganisms are rapidly destroy at temperature ranging from 49-91oC. Treatment method type will be depend upon the temperature range used for the process.</p> <p>Autoclaving:- In this method steam is used for the sterilization. It is brought in direct contact with waste. Steam, autoclaving combines moisture, heat, and pressure to inactivate microorganisms. This process has been used for sterilizing medical instruments in hospitals for many years and the validation of autoclaving as a sterilization technique for medical equipment and supplies is well documented. All autoclaves are constructed with a metal chamber to withstand the increased pressure/temperature required to insure destruction of bacteria, viruses, and bacterial spores. Autoclaves come in two basic varieties,</p>	<p>1</p> <p>3</p>	<p>4</p>



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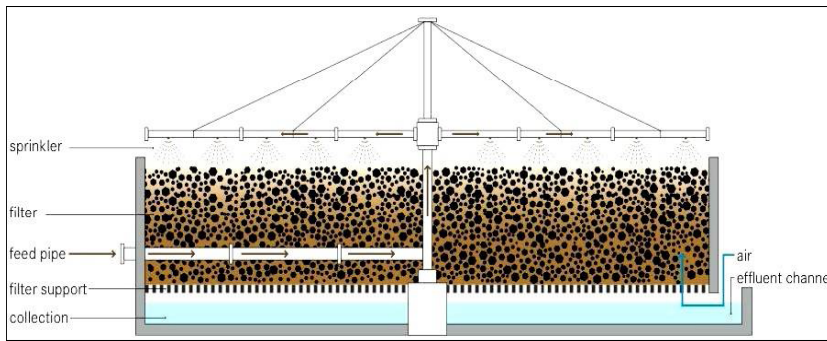
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	<p>gravity displacement autoclaves and pre vacuum autoclaves. The size of the device may vary from bench top models designed to hold a single bag of waste to large commercial devices that can treat more than a ton of waste per cycle. Any test method developed for assessing the efficacy of treating biomedical waste in a steam autoclave should be applicable to all types and sizes of autoclaves that may be used as waste treatment devices.</p> <p>Microwave treatment method:- In microwaving, microbial inactivation occurs as a result of the thermal effect of electromagnetic radiation spectrum lying between the frequencies 300 and 300,000 MHz. Microwave heating is an inter-molecular heating process. The heating occurs inside the waste material in the presence of steam.</p> <p>The Microwave disinfection unit (MDU) disinfects infectious medical waste through the application of steam and microwave radiation. The infectious material is temporarily held in a waste container(s), which in turn, are emptied into an in-feed hopper via a charging system. The charging system is located at the front of the MDU. The infectious waste is fed to a shredder by the feed arm where it is shredded. The shredded material is conveyed through the microwave section and temperature holding section, respectively for disinfection. The outlet of the temperature holding section protrudes near the back end of the unit and is designed to transport the disinfected waste into waste disposal containers (or compaction units). From there the material can be transported to a local municipal landfill for disposal or to a refuse recycling plant or wherever ordinary household solid waste is disposed.</p>		
c)	<p>Trickling filter</p> <p>A trickling filter is used for treatment of waste water. It consists of a bed of highly permeable media on whose surface a mixed population of</p>	04	04



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microorganisms is developed as a slime layer. Passage of wastewater through the filter causes the development of a gelatinous coating of bacteria, protozoa and other organisms on the media. With time, the thickness of the slime layer increases preventing oxygen from penetrating the full depth of the slime layer. In the absence of oxygen, anaerobic decomposition becomes active near the surface of the media



Sprinkler : To sprinkle waste water on filter

Filter: To hold biological slime

Feed pipe : Inlet for waste water

Filter support: To hold filter media

Effluent channel: to take out treated waste water

d)

Business Benefits of ISO14000:

1. Efficiency, discipline and operational integration with ISO 9000
2. Greater employee involvement in business operations with a more motivated workforce
3. Easier to obtain operational permits and authorizations
4. Assists in developing and transferring technology within the company

½ mark
each
for any
8

04

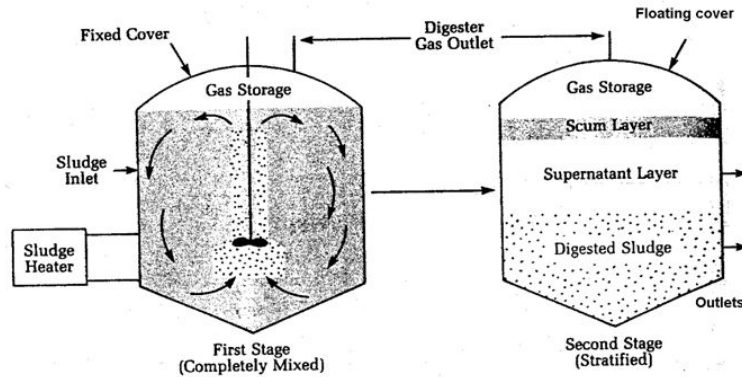


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	<ol style="list-style-type: none">5. Helps reduce pollution6. Fewer operating costs7. Savings from safer workplace conditions8. Reduction of costs associated with emissions, discharges, waste handling, transport & disposal9. Improvements in the product as a result of process changes10. Safer products11. Minimizes hazardous and non-hazardous waste12. Conserves natural resources - electricity, gas, space and water with resultant cost savings13. Prevents pollution and reduces wastage14. Demonstrates to customers that the firm has met environmental expectations.15. Meets potential national and international government purchasing requirements.16. Delivers profits from marketing "green" products17. Provides a competitive marketing tool18. Improves international competitiveness19. Improves the organization's relationship with insurance companies20. Elimination of costs associated with conformance to conflicting national standards21. Process cost savings by reduction of material and energy input22. Satisfying investor / shareholder criteria23. Helps reduce liability and risk24. Improved access to capital		
e)	Two Stage sludge digester		4



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After concentration, the sludge is stabilized by digesting it under anaerobic conditions. Anaerobic digestion is the most common method in which the organic content of the sludge decomposes to give mainly methane and carbon dioxide and at the same time the bound water is released from the sludge. Properly digested sludge is black with a faint smell of tar, and is stable. In a typical sludge digester, shown in figure, raw sludge is fed into the active digestion zone and gas lifts the sludge particles and other materials which form a supernatant layer on the top of the digestion zone. The gas is collected at the top and the digested sludge is withdrawn from the bottom. The normal detention period in the standard digester varies from 30 to 70 days depending upon the temperature conditions.

2

2

f)

Thermal Pollution- sources

Thermal pollution includes the waste mainly heat discharged from atomic, nuclear and thermal power plants. The discharge of unutilized heat is highest in the thermal power plants which adversely affect the aquatic environment. Apart from electric power plants; various industries with cooling requirement contribute to thermal loading. Municipal sewage also contributes to thermal pollution. Domestic sewage normally has a higher temperature than receiving

1

4



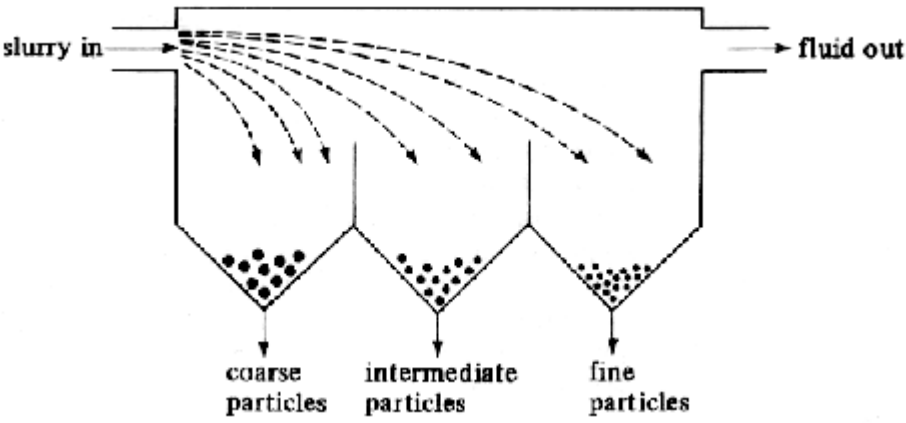
SUMMER-16 EXAMINATION

Model Answer

	<p>water.</p> <p>Effect of Thermal pollution on water are:</p> <p>i)Reduction in dissolved oxygen</p> <p>ii) Decreases the oxygen saturation percentage</p> <p>iii)Increase in BOD</p> <p>iv) Early hatching of fish eggs.</p> <p>v) Failure of trout (cold water fish) eggs to hatch and salmon to spawn</p> <p>vi) Direct fish mortality due to failure in respiratory, nervous or essential cell processes.</p> <p>vii) Bacteria multiply rapidly, which in turn become the food of protozoans.</p> <p>viii) Undesirable changes in algal population.</p> <p>ix) Excessive eutrophication.</p> <p>x) increases the toxicity of some chemical pollutants</p> <p>xi) migration of aquatic biota</p> <p>xii) Decrease in solubility of gases in water.</p> <p>xii) Rapid setting of sediment load in water affecting aquatic food supply.</p>	<p>½ mark each for any 6</p>	
6	Attempt any Four		16
a)	<p>Working Principle of Gravity settling chamber :</p> <p>Gravitational force may be employed to remove particulate in settling chambers when the settling velocity is greater than about 0.12m/s. Gravity settling chambers are provided with enlarged areas to minimize horizontal velocities and allow time for the vertical velocity to carry the particle to the floor.</p> <p>The gravitational settling chambers are usually operated with velocity between 0.5 to 2.5 m/s. Some settling chambers have simply enlarged conduits and some have horizontal shelves and baffles, spaced about 2.5cm apart. The horizontal shelves shorten the settling path of the particles and improve</p>	<p>2</p>	<p>4</p>



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	<p>removal efficiency. Gravitational settling chambers are generally used to remove large, abrasive particles (usually $>50 \mu\text{m}$) from gas streams. They offer low pressure drop and require simple maintenance, but their efficiencies are quite low for particles smaller than $50 \mu\text{m}$. Since most of the troublesome particles have much smaller sizes than $50 \mu\text{m}$ these devices are normally used as precleaners prior to passing the gas stream through high efficiency collection devices.</p> 	2	
b)	<p>Working of fabric filter</p> <p>Dust-laden gas or air enters the fabric filter through hoppers (large funnel-shaped containers used for storing and dispensing particulate) and is directed into the fabric filter compartment. The gas is drawn through the bags, either on the inside or the outside depending on cleaning method, and a layer of dust accumulates on the filter media surface until air can no longer move through it. When sufficient pressure drop (ΔP) occurs, the cleaning process begins. Cleaning can take place while the fabric filter is online (filtering) or is offline (in isolation).</p> <p>When the compartment is clean, normal filtering resumes.</p> <p>Fabric filter are very efficient particulate collectors because of the dust cake</p>	02	04



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formed on the surface of the bags.

The fabric provides a surface on which dust collects through the following four mechanisms:

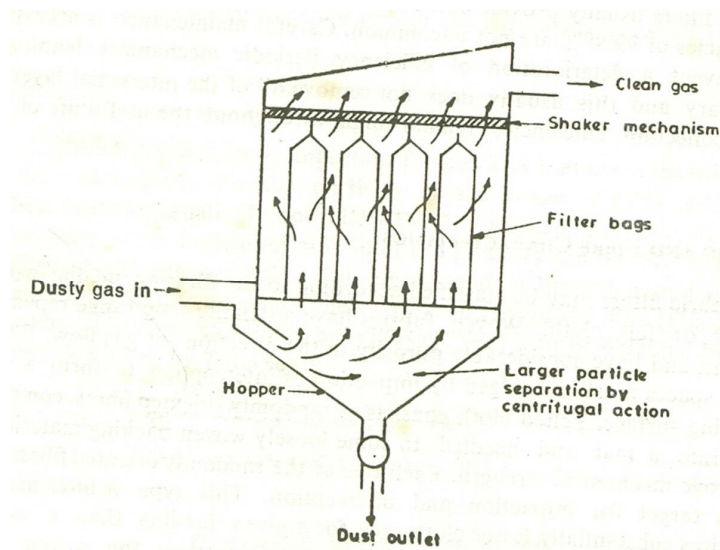
Inertial collection - Dust particles strike the fibers placed perpendicular to the gas-flow direction instead of changing direction with the gas stream.

Interception - Particles that do not cross the fluid streamlines come in contact with fibers because of the fiber size.

Brownian movement- Sub micrometer particles are diffused, increasing the probability of contact between the particles and collecting surfaces.

Electrostatic forces - The presence of an electrostatic charge on the particles and the filter can increase dust capture.

A combination of these mechanisms results in formation of the dust cake on the filter, which eventually increases the resistance to gas flow. The filter must be cleaned periodically.



02



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c)	<p>DO:- Dissolved oxygen (DO) is the amount of oxygen that is present in the water. It is measured in milligrams per liter (mg/L), or the number of milligrams of oxygen dissolved in a liter of water. In order to metabolize food and reproduce, each microorganism (or bug) must have at least 0.1 to 0.3 mg/L DO. In waste water treatment oxygen must be provided for the microorganism by forcing it into water by aerator.</p> <p>TDS:- Total dissolved solids (TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular (colloidal sol) suspended form.</p> <p>It is generally agreed that the total dissolved solids concentration of good, palatable drinking water should not exceed 500 mg/L. However, higher concentrations may be consumed without harmful physiological effects and may indeed even be more beneficial. This limit was primarily set on the basis of taste thresholds. Livestock and wildlife may be injured by drinking water that contains excessive dissolved solids.</p>	2	4
d)	Pollutants from Pulp and Paper industry	4	4



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	Source	Major Pollutants		
	Chemical Pulping Process	VOCs (terpenes, alcohols, phenols, methanol, acetone, chloroform, methyl ethyl ketone [MEK])		
		Reduced sulfur compounds (TRS)		
		Organo-chlorine compounds		
	Bleaching	VOCs (acetone, methylene chloride, chloroform, MEK, chloromethane, trichloroethane)		
	Wastewater Treatment Plant	VOCs (terpenes, alcohols, phenols, methanol, acetone, chloroform, MEK)		
	Power Boiler	SO ₂ , Nox, fly ash, coarse particulates		
	Evaporator	Evaporator noncondensibles (TRS, volatile organic compounds: alcohols, terpenes, phenols)		
	Recovery Furnace	Fine particulates, TRS, SO ₂ , Nox		
	Calcining (Lime Kiln)	Fine and coarse particulates		
e)	<p>Comminutors can be used in wastewater treatment to cut up and grind the coarse solids into smaller sizes so that this will eliminate the problems caused towards downstream operations especially clogging happening in pumps. Different from bar racks and coarse screens, it does not involve having to remove any type of solid out from the flow system and thus void the necessity of messy jobs having to clean and handle on solid waste disposal. Its use and application is particular important in treatment plants located in cold climates areas whereby use of comminutors means there will not be any issue with collected waste becoming trapped on freezing screens.</p> <p>The devices are usually installed in wastewater pumping stations whereby its role is to protect the pumps from damage. Once the solids are reduced to smaller and more uniformed sizes, it can be returned and move towards subsequent processes without requiring the needs for manual jobs and manpower intervention to clear up the trapped waste materials. Although overall, this is seen as a time-saving operation with less disruption to the flow</p>		4	4

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	system, but however, since the solids are still present in water, subsequent agitation that usually takes place in grit chambers will again recombine it back to form lumps and strands. All these will pose potential problems related to clogging happening in heat exchangers, air diffusers in aeration pond and further buildup might even lead to pipelines getting choked up.																
f)	Types of Solid Waste <table border="1"><thead><tr><th>Types</th><th>Example of sources</th></tr></thead><tbody><tr><td>Food wastes</td><td>Animal, fruits and vegetable residues resulting from the handling and preparation, cooking and eating of foods</td></tr><tr><td>Rubbish</td><td>1. combustible papers, plastics, leather, cardboard, wood, rubber etc. 2. Non-combustible glass, aluminium cans, crockery, tin cans, dirt, construction wastes.</td></tr><tr><td>Ashes and residue</td><td>Material remaining from the burning of wood, coal, and coke and other combustible wastes in homes, stores, industrial and municipal facilities for the purpose of heating and cooking</td></tr><tr><td>Demolition and construction waste</td><td>Wastes from construction, remoulding, repairing of residential, commercial and industrial buildings</td></tr><tr><td>Special waste</td><td>1. street sweepings. 2. road side litter from municipal litter containers. 3. Dead animals</td></tr><tr><td>Treatment plant waste</td><td>From water, waste water and industrial waste</td></tr></tbody></table>	Types	Example of sources	Food wastes	Animal, fruits and vegetable residues resulting from the handling and preparation, cooking and eating of foods	Rubbish	1. combustible papers, plastics, leather, cardboard, wood, rubber etc. 2. Non-combustible glass, aluminium cans, crockery, tin cans, dirt, construction wastes.	Ashes and residue	Material remaining from the burning of wood, coal, and coke and other combustible wastes in homes, stores, industrial and municipal facilities for the purpose of heating and cooking	Demolition and construction waste	Wastes from construction, remoulding, repairing of residential, commercial and industrial buildings	Special waste	1. street sweepings. 2. road side litter from municipal litter containers. 3. Dead animals	Treatment plant waste	From water, waste water and industrial waste	4	4
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		treatment plants		
	Hazardous wastes	Chemical Biological Flammable explosive		
	Agricultural wastes	Planting Harvesting of crops, fields etc.		