

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.
- 5) 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

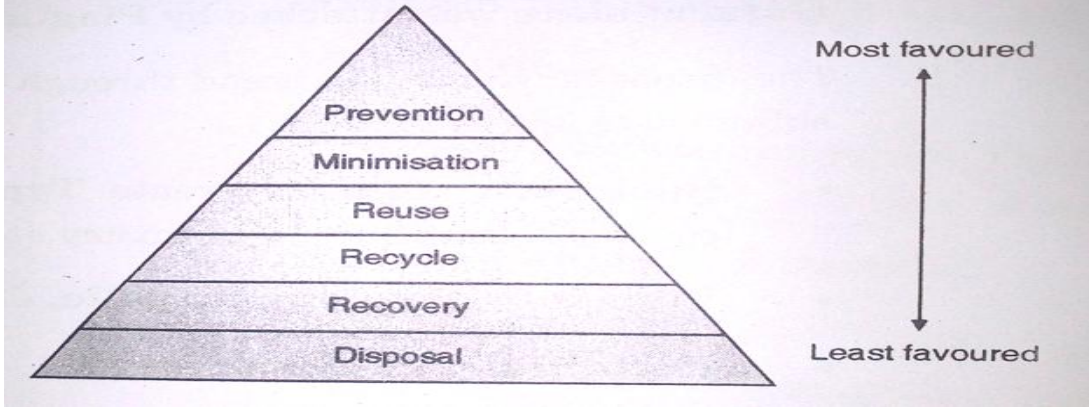
- 1) In Q.5. f) Student may write any recycling of any industrial waste so credit may give according to that.**

Q .NO	SOLUTION	MARKS
Q1.	Attempt Any Ten of the following:	20M
a)	State the principles of aerobic composting.	02 M
	In Aerobic composting, aerobic micro-organism oxidizes organic compounds to carbon dioxide, nitrite and Nitrate. Carbon from organic compounds is used as source of energy while nitrogen is recycled. Due to Exothermic Reaction, temperature of the mass rises.	02M
b)	How C/N ratio affects composting process?	02 M
	i) If the C/N ratio is too high, the composting time increases because the available nitrogen is used up quickly and the micro-organisms must find it elsewhere. ii) If the C/N ratio is too low, the nitrogen is released as gas, causing an unpleasant odour of ammonia.	02M
c)	Define: i) Leachate ii) Pyrolysis	02 M
	i) A leachate is any liquid that, in the course of time passing through matter, extracts soluble or suspended solids, or any other component of the material through which it has passed. ii) Pyrolysis can be <i>defined</i> as the thermal decomposition of organic material through the application of heat without the addition of extra air or oxygen.	1 M each
d)	What is Biogas?	02 M
	Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste.	02M
e)	What is Vermicomposting?	02 M
	Vermicomposting is the breaking down of organic material through the use of worms, bacteria, and fungi. In nature, organic matter is decomposed through these organisms. By managing vermicomposting you are essentially speeding up mother nature's process of breaking down organic matter.	02 M
f)	What is Incineration of solid waste?	02 M
	Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials. Incineration and other high-temperature waste treatment systems are described as "thermal treatment". Incineration of waste materials converts the waste into ash, flue gas, and heat.	02 M
g)	State the objectives of Biomedical waste management.	02 M
	<ul style="list-style-type: none"> ➤ Define Medical Waste, Regulated Medical Waste and Infectious Waste. ➤ Discuss the Regulations Applicable to Medical Waste. ➤ Discuss the Components of an Infectious Waste Management Plan. ➤ Outline an Exposure Control Plan. ➤ Discuss Steps to take if exposed to Infectious Waste. ➤ Discuss the Problem of Mercury. ➤ Discuss Records to Maintain. ➤ Recommend Inspection Items. ➤ Discuss Use of Contractors. 	½ each Write any Four

h	What is Biomedical waste?	02 M																
	In this course, medical waste includes all infectious waste, hazardous (including low-level radioactive wastes), and any other wastes that are generated from all types of health care institutions, including hospitals, clinics, doctor’s (including dental and veterinary) offices and medical laboratories.	02 M																
i	Define E waste. Give examples.	02 M																
	i) E-waste is any refuse created by discarded electronic devices and components as well as substances involved in their manufacture or use. ii) Examples-: computers, office electronic equipment, entertainment device electronics, mobile phones, television sets, and refrigerators.	1 M 1M For Example																
j	Give the colour coding used for sorting of biomedical waste.	02 M																
	<table border="1"> <thead> <tr> <th colspan="2">SEGREGATION GUIDELINES*</th> </tr> <tr> <th>COLOUR</th> <th>WASTE DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>YELLOW*</td> <td>Human tissues, organs, body parts, items contaminated by blood/body fluids, soiled cotton & dressing, soiled plaster casts etc.</td> </tr> <tr> <td>RED*</td> <td>Catheters, tubes, cannulae, syringes, plastic IV bottles & sets, used gloves, infected plastics, specimen containers, lab waste, microbiology cultures, used or discarded bags of blood/blood products, vaccines etc.</td> </tr> <tr> <td>BLUE*</td> <td>Glass items, needles, syringes, scalpels, blades, used and unused sharps etc.</td> </tr> <tr> <td>BLACK*</td> <td>Discarded medicines, discarded cytotoxic drugs etc.</td> </tr> <tr> <td>GREEN</td> <td>General waste, non-infected plastic materials & papers, disposables, cardboards, metal containers, office waste, food waste etc.</td> </tr> <tr> <td colspan="2">*Recommended by CPCB</td> </tr> </tbody> </table>	SEGREGATION GUIDELINES*		COLOUR	WASTE DESCRIPTION	YELLOW*	Human tissues, organs, body parts, items contaminated by blood/body fluids, soiled cotton & dressing, soiled plaster casts etc.	RED*	Catheters, tubes, cannulae, syringes, plastic IV bottles & sets, used gloves, infected plastics, specimen containers, lab waste, microbiology cultures, used or discarded bags of blood/blood products, vaccines etc.	BLUE*	Glass items, needles, syringes, scalpels, blades, used and unused sharps etc.	BLACK*	Discarded medicines, discarded cytotoxic drugs etc.	GREEN	General waste, non-infected plastic materials & papers, disposables, cardboards, metal containers, office waste, food waste etc.	*Recommended by CPCB		½ each Write any Four
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k)	What are dangerous constituents of E-waste?	02 M																
	E-waste-connected health risks may result from direct contact with harmful materials such as lead, cadmium, chromium, brominated flame retardants or polychlorinated biphenyls (PCBs), from inhalation of toxic fumes, as well as from accumulation of chemicals in soil, water and food.	½ each Write any Four																
l)	Enlist different industrial wastes.	02 M																
	<p>Examples of industrial wastes are</p> <ul style="list-style-type: none"> ➤ Chemical solvents, ➤ Paints ➤ Sandpaper ➤ Paper products ➤ Industrial by-products ➤ Metals ➤ Radioactive wastes <p>NOTE-Examiner may judge any other waste mentioned by students give.</p>	½ each Write any Four																

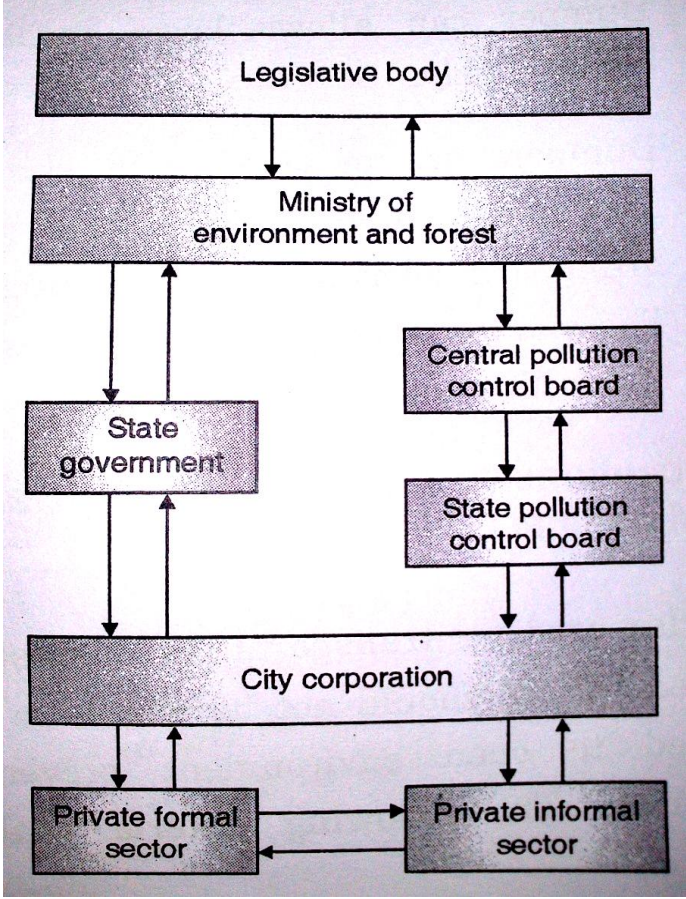
m)	What are the types of environmental and health hazards?	02 M
	Hazards can be categorized in five types: <ul style="list-style-type: none"> ➤ Chemical ➤ Physical ➤ Mechanical ➤ Biological ➤ Psychosocial 	½ each Write any Four
n)	What is centralized sorting of solid waste?	02 M
	centralized sorting of solid waste the separation of bulky items, separation of waste components by size using screens, manual separation of waste components, and separation of ferrous and non-ferrous metals.	02 M
o)	What is the purpose of recycling?	02 M
	<ul style="list-style-type: none"> ➤ To Make Environment Clean ➤ Conservation of Materials ➤ To Save Energy ➤ Reduce Garbage in Landfills ➤ Reduce the pollution. 	½ each Write any Four
Q No.2	Attempt <u>Any FOUR</u> of the following	16 M
a)	State the factors affecting the generation of solid waste.	04 M
	Factors affecting on solid waste generation. <ul style="list-style-type: none"> ➤ Source reduction/recycling ➤ Geographic location ➤ Season ➤ Collection Frequency ➤ Per capita income ➤ Public attitudes ➤ Size of households ➤ Population density ➤ Population increase 	½ each Write any Eight

b)	Classify solid wastes. Give meaning of each with examples.		04 M
	<i>Type of solid waste</i>	<i>Description</i>	½ each Write any Eight
Food Waste (garbage)	Waste from preparation, cooking and serving of food market refuse, waste from handling, storage and sale of meat and vegetables		
Rubbish	Combustible (primarily organic) paper, cardboards, cartons, wood boxes, plastics, rags, clothes, beddings, lather rubber grass, leaves yard trimmings. Non combustible (primarily inorganic) metals, tin cans, metal foils, dirt, stones bricks, ceramics, crockery, glass bottles, other mineral refuse		
Ashes and residues	Residues from fires used for cooking and for heating buildings, cinders, clinkers, thermal power plants.		
Bulky waste	Large auto parts, tyres stoves, refrigerators, other large appliances, furniture, large crates, branches of trees etc.		
Street waste	Street sweepings, dirt, leaves, catch basin dirt animal droppings content of litter receptacles dead animals		
Dead animals	Small animals: cats, dogs, poultry etc. Large animals: horses, cows etc.		
Construction and demolition waste	Plumber, roofing and sheathing scrap, rubble broken concrete plaster, conduit pipes, insulating wires etc.		
Industrial waste & sludges	Solid wastes resulting from industry processes and manufacturing operations, such as food processing wastes, boiler house cinders, wood plastic and metal scraps and shavings etc., sludge of sewage treatment plants and septic tanks, coarse screenings grit etc.		
Hazardous waste	Hazardous wastes: pathological waste, explosives, radioactive material toxic waste etc.		
Horticulture wastes	Tree trimmings, leaves, waste from parks and gardens etc.		

<p>c)</p>	<p>What do you mean by solid waste management hierarchy?</p>  <p style="text-align: center;">Solid waste management hierarchy</p> <p>The main aim of waste hierarchy is to generate minimum amount of waste and obtain maximum benefits from products.</p> <p>Following are the various stages in SWM Hierarchy:</p> <ol style="list-style-type: none"> 1. <u>Prevention</u>: preventing the use of such raw material in production which produces maximum solid waste and selecting the alternative raw materials. 2. <u>Minimization</u>: if such alternative raw materials are less possible then minimize the use of raw materials producing more waste by implementing different techniques. 3. <u>Reuse</u>: it is the next desirable option in which materials some materials are repeatedly used again and again for same purpose. 4. <u>Recycle</u>: In this stage collection, sorting of recyclable products is done and then they are manufactured into new products. 5. <u>Recovery</u>: in this stage the recoverable materials are processed which includes activities like recycling and composting. 6. <u>Disposal</u>: It is the last option and should be considered after all other possible actions to recover that waste matter. It may includes incineration, dumping. 	<p>04 M</p> <p>02 M For Diagram</p> <p>02 M For Explanation</p>
<p>d)</p>	<p>Describe physical and chemical characteristics of solid wastes.</p> <p>1) Physical characteristics</p> <p>i) Specific Weight (Density)</p> <ul style="list-style-type: none"> ➤ Specific weight is defined as the weight of a material per unit volume (e.g. kg/m³, lb/ft³) ➤ Usually it refers to uncompacted waste. ➤ It varies with geographic location, season of the year, and length of time in storage. <p>ii) Moisture Content</p> <ul style="list-style-type: none"> ➤ The moisture in a sample is expressed as percentage of the wet weight of the MSW (Municipal Solid Waste) material. <p>iii) Particle Size and Distribution.</p> <ul style="list-style-type: none"> ➤ The size and distribution of the components of wastes are important for the recovery of materials, especially when mechanical means are used, such as trommel screens and magnetic separators. 	<p>04 M</p> <p>1M For Each Physical Properties</p> <p><u>Write ANY TWO</u></p>

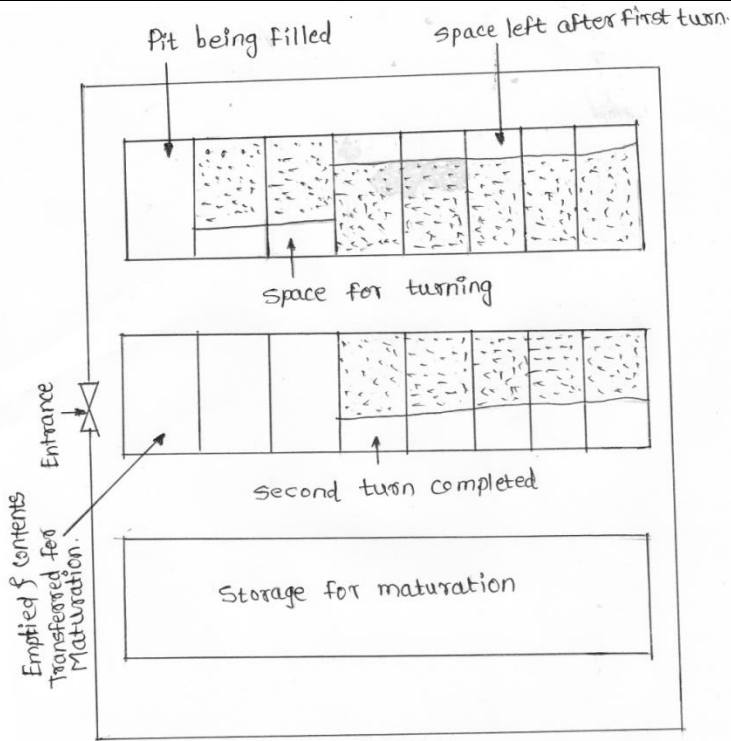
	<p>iv) Field Capacity</p> <ul style="list-style-type: none"> ➤ The total amount of moisture that can be retained in a waste sample subject to the downward pull of gravity. ➤ Field capacity is critically important in determining the formation of leachate in landfills ➤ It varies with the degree of applied pressure and the state of decomposition of wastes, but typical values for uncompacted commingled wastes from residential and commercial sources are in the range of 50 - 60%. <p>v) Permeability of Compacted Waste</p> <ul style="list-style-type: none"> ➤ The permeability (hydraulic conductivity) of compacted solid waste is an important physical property because it governs the movement of liquids & gases in a landfill. <p>2) <u>Chemical characteristics</u></p> <ul style="list-style-type: none"> ➤ Used primarily for combustion and waste to energy (WTE) calculations but can also be used to estimate biological and chemical behaviors. ➤ Waste consists of combustible (i.e. paper) and non-combustible materials (i.e. glass). <p>Proximate Analysis</p> <ul style="list-style-type: none"> ➤ Loss of moisture (temp held at 105 °C) ➤ Volatile Combustible Matter (VCM) (temp increased to 950 °C, closed crucible) ➤ Fixed Carbon (residue from VCM) ➤ Ash (temp = 950°C, open crucible) <p>Fusing Point of Ash</p> <ul style="list-style-type: none"> ➤ Clinker (agglomerations of carbon and metals) formation temperature, 2000 °C to 2200 °C <p>Ultimate Analysis</p> <ul style="list-style-type: none"> ➤ Molecular composition (C, H, N, O, P, etc.) <p>Energy Content</p> <ul style="list-style-type: none"> ➤ Determined through lab calculations using calorimeters. 	<p>1M For Each Chemical Properties</p> <p><u>Write</u> <u>ANY</u> <u>TWO</u></p>
e)	Describe the impact of solid waste on environment.	04 M
	<ul style="list-style-type: none"> ➤ Waste breaks down in landfills to form methane, which causes greenhouse gas. Carbon dioxide and Methane produced from solid waste are extremely harmful to the environment. ➤ Change in climate and destruction of ozone layer due to waste biodegradable ➤ Due to waste pollutions, illegal dumping, Leaching: is a process by which solid waste enter soil and ground water and contaminating them and Pollute water bodies. ➤ Open air dumping creates unhygienic and poses enormous threat to the people. ➤ Causes aesthetic problem and nuisance due to nauseating pungent odor. ➤ Promotes spreading of diseases. ➤ The situation further aggravated by the indiscriminate disposal of Hospital and Clinical Waste. ➤ Presence of extremely high level of total and Facial E-coli form. 	04 M
f)	Enlist different sources of solid waste.	04 M
	<p>1) Residential 2) Commercial 3) Institutional 4) Construction and Demolition 5) Municipal Services 6) Treatment Plant Sites 7) Industrial 8) Agricultural</p>	½ Each

Q No-3	Attempt <u>Any FOUR</u> of the following:	16 M
a)	Describe transfer station with meaning, necessity and location.	04 M
	<p>i) Transfer station: These are the open or closed structures built by competent authority at various locations in city and waste collected by hauling vehicles is initially transferred to these stations.</p> <p>ii) Location-: A transfer station is a building or processing site for the temporary deposition of waste. Transfer stations are often used as places where local waste collection vehicles will deposit their waste cargo prior to loading into larger vehicles. These larger vehicles will transport the waste to the end point of disposal in an incinerator, landfill, or hazardous waste facility, or for recycling.</p> <p><u>Necessity of transfer stations:</u> Transfer stations are necessary due to following reasons</p> <ol style="list-style-type: none"> 1. They prevent the scattering of MSW. 2. To have ease in proper storage and collection of MSW from different locations. 3. To prevent nuisance due to scattered solid waste to nearby area. To reduce the haul distance. 	02 M
b)	What are the measures to be taken to improve the transportation system for SWM?	04 M
	<p>Solid waste collected at several locations in the city is required to be transported to treatment and disposal site. Guidelines of Solid Waste Management Act in respect of transportation is given below</p> <ul style="list-style-type: none"> ➤ Vehicle used for transportation of wastes shall be covered. ➤ Waste should not be visible to public nor exposed to open environment preventing their scattering. The following criteria shall be met : ➤ The storage facilities set up by Municipal authorities shall be daily attended for cleaning of wastes. ➤ Collection and transportation vehicles shall be so designed such that multiple handling of wastes, prior to final disposal is avoided. ➤ Transportation system for solid waste management is designed keeping above requirement in mind. ➤ The transport Vehicle should be strong durable and water tight, it should made of steel with smooth interior surface. 	04 M
c)	Explain the organizational pattern of solid waste management.	04 M
	<ul style="list-style-type: none"> ➤ Solid Waste Management activity has been decentralized zone wise. ➤ At the Head Office the Chief Engineer is in charge for establishment of processing and disposal sites ➤ The zonal officers look after the collection and transportation of solid waste. ➤ About 80 % of the MSW activity has been outsourced ➤ Small numbers of Self Help Group's (SHGs) are engaged in door to door collection in some of the new areas. 	02 M For Explain- ation

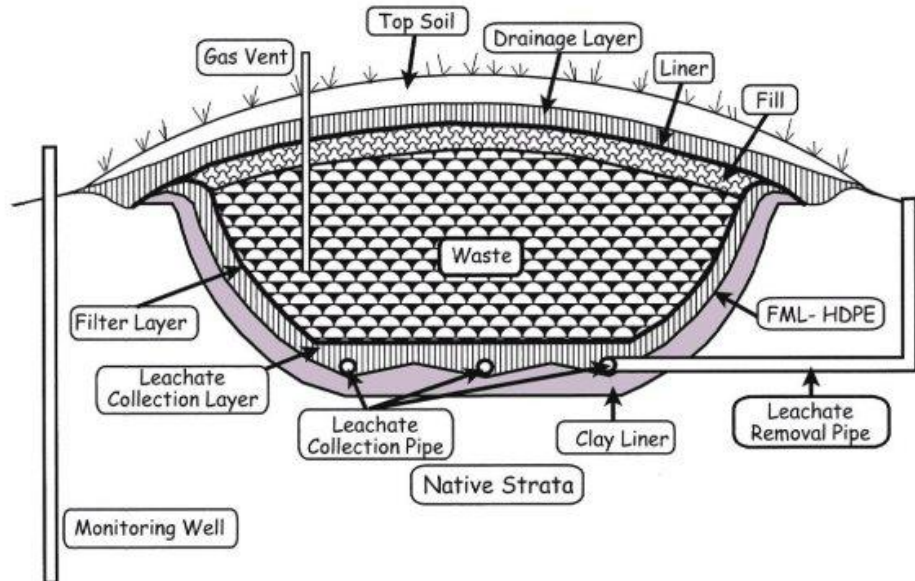
<p>c) Cont.</p>	 <p>The diagram illustrates the organizational structure of Solid Waste Management (SWM) administration. At the top is the Legislative body, which has a bidirectional relationship with the Ministry of environment and forest. The Ministry of environment and forest has bidirectional relationships with the State government and the Central pollution control board. The State government has bidirectional relationships with the State pollution control board and the City corporation. The Central pollution control board has bidirectional relationships with the State pollution control board. The State pollution control board has bidirectional relationships with the City corporation. The City corporation has bidirectional relationships with both the Private formal sector and the Private informal sector. There are also bidirectional relationships between the Private formal sector and the Private informal sector.</p> <p>Organizational setup of Solid waste Management (SWM) administration</p>	<p>02 M For Diagram</p>
<p>d)</p>	<p>Describe different methods of collection of solid wastes.</p>	<p>04 M</p>
	<ul style="list-style-type: none"> • Municipal Collection Service • Although a variety of collection services are available the three most common are curb, alley and backyard collection. Curb collection has gained popularity because labour costs for collection can be minimized. In the future, it appears that the use of large container which can be emptied mechanically with an articulated container pickup mechanism will be the most common method used for the collection of municipal wastes. • Curb Service: The house owner is responsible for placing the solid waste containers at the curb on the scheduled day. The workmen come, collect and empty the container and put back at the curb. The house owner is required to take back the empty containers from the curb to his house. • Alley Service: The containers are placed at the alley line from where they are picked up by workmen from refuse vehicle who deposit back the empty container. • Set out Set Back Service: Set out man go to the house collect containers and empty them in the refuse vehicle. Another group of persons return them to the house owner's yard • Backyard Service: The workers with the vehicles carry a bin, wheel-barrow or sack or cloth to the yard and empty the solid waste container in it. The wheel barrow or bin is then taken to solid waste vehicle where it is emptied. 	<p>2M (For Any 2 Method)</p>

<p>d) Cont.</p>	<ul style="list-style-type: none"> • Set out-the workers with refuse vehicles collect containers from individual houses and empty then in refuse vehicles. the empty containers are collected by house owners • Storage bin-An empty storage container (Known as a drop-off box) is hauled to the storage site to replace the container that is full of waste, which is then hauled to the processing point, transfer station or disposal site. 	
<p>e)</p>	<p>What are the arrangements to be made for the efficient storage of household waste?</p>	<p align="right">04 M</p>
	<ul style="list-style-type: none"> ➤ All Householders must only present waste for collection by a permitted waste collector. ➤ All householders must present waste for collection if they are on a collection route or retain all records i.e. receipts/dockets as proof of the proper disposal of their household waste. ➤ All waste must be stored and presented in appropriate receptacles in a manner that would not endanger health, create a risk to traffic, harm the environment or create a nuisance such as odour or litter. ➤ All recyclables must be separated at source and presented for collection in appropriate receptacle. ➤ If a separate organic collection service is made available this waste shall also be separated at source for collection ➤ Receptacles must not be overfilled and lids must be closed at all times. ➤ Householders must not present waste for collection prior to 6pm on the eve of collection day. ➤ Householder must remove any waste containers and/or uncollected waste from point of collection within 12hrs of the designated collection time. ➤ It is advised for the storage of bio-degradable or wet waste the container should be of capacity 15 lit. 	<p align="right">(1/2 mark for each point) <u>Write any Eight</u></p>
<p>f)</p>	<p>State the goals/requirements applicable to transportation vehicles for solid waste.</p>	<p align="right">04 M</p>
	<ul style="list-style-type: none"> ➤ The waste is transported from the storage depots to the disposal sites in tractor trolleys or ill designed open trucks. ➤ Though it has been instructed by the law that the transportation must be done in closed containers only. ➤ The industrial waste must be transported separately and must be disposed in a safe way after suitable treatment. ➤ Any type of the Hazardous waste should be labeled and coded so that in case of an accident the emergency services know how to handle a spillage. ➤ The loading height of vehicles receiving the contents of containers emptied manually should not exceed 1.6m. ➤ Transportation system has to be so design that it is efficient and cost effective. 	<p align="right">(1M for each point) <u>Write any Four</u></p>

Q No-4	Attempt Any FOUR of the following:	16 M
a)	Describe Indore and Bangalore methods of composting.	04 M
	<p><u>I) Indore method</u></p> <ul style="list-style-type: none"> ➤ Indore method layers of vegetable and night soil is alternative piled into trench, the depth of pile is 1.5-2m and widths is about 3-8m or above the ground form a mound called windrow. ➤ Normally windrows are conical in shape and about 50m in length. ➤ The aeration is achieved by periodically turning the piles. Manual turning is ➤ Adopted for small plants and mechanical turning is adopted for larger plants. ➤ Refuse should be turn once or twice per week which introduce oxygen and helps to control temperature. ➤ Turning continued for about 4-5 weeks during which biodegradable organic are Consumed. The solid waste is allowed to keep for 2-8 weeks with turning the Composting in windrow may take 21-28 days for stabilization. ➤ The composted waste is removed from windrow and allowed to mature in maturing yards for 1-3 months, after which the compost becomes ready for being taken out for use. <p><u>II) Bangalore method</u></p> <ul style="list-style-type: none"> ➤ Bangalore method is commonly used anaerobic method used for biological used anaerobic method used for biological conversion of organic component of municipal solid waste. ➤ In this method underground earthen trench is excavated and alternate layer of waste and soil is filled in trench or pit to control odour.final layer of soil is provide at top. ➤ The soil cover not only prevent odour but also prevents breeding of files. ➤ Within 2-3 days of burial intensive biological action starts taking place and organic matter beings to be destroyed. After 4-5 months complete stabilization of waste takes placed. ➤ During biological action head is evolved which rises temperature of decomposing mass. 	2M for each Method
b)	Describe mechanical composting.	04 M
	<ul style="list-style-type: none"> ➤ In the process of stabilization is expiated by mechanical device of turning the compost. It is recommended to use refuse of 1.5cm particle size in this method. The moisture content and aeration of refuse are continually adjusted. Care is taken to see that quantity of air should not exceed $2m^3/kg$ of volatile solid per day. ➤ It requires small area compare to trenching and open windrow composting. ➤ The stabilization of waste takes 3 – 6 days. ➤ The operation involved are <ul style="list-style-type: none"> • Reception of refuse • Segregation • Shredding • Stabilization • Marketing 	02 M For Explanation

<p>b) Cont.</p>	 <p style="text-align: center;">Composting Mechanical Composting</p>	<p style="text-align: center;">02 M For Diagram</p>
<p>c)</p>	<p>Describe any one method of land filling.</p>	<p style="text-align: center;">04 M</p>
	<p>Land filling methods</p> <ul style="list-style-type: none"> ➤ Area method ➤ Trench method ➤ Ramp method <p>Area method</p> <ul style="list-style-type: none"> ➤ The Area Method is used when the terrain is unsuitable for the excavation of trenches in which to place the solid wastes. The filling operation usually is started by building an earthen bund against which wastes are placed in thin layers and compacted as the fill progresses until the thickness of the compacted wastes reaches a height of 2 to 3 m at the end of day's operation a 150 mm to 300 mm layer of cover material is placed over the compacted fill. The cover material must be hauled in by truck or earth-moving equipment from adjacent land or from borrow-pit areas. A final layer of cover material is used when the fill reaches the final design height. <p style="text-align: center;">OR</p> <p>Trench method</p> <ul style="list-style-type: none"> ➤ The trench method is suited to areas where an adequate depth of cover material is available at the site ➤ Where the water table is well below the surface. ➤ To start the process, a portion of the trench is dug with a bulldozer and the dirt is stockpiled to form an embankment behind the first trench. ➤ Wastes are then placed in the trench, spread into thin layers and compacted. ➤ The operation continues until the desired height is reached. ➤ Cover material is obtained by excavating an adjacent trench or continuing the trench that is being filled. 	<p style="text-align: center;">4 Mark for any One method</p>

- These landfills may also accept C&DD debris, but not hazardous waste.
- The minimum requirement for MSW landfills is a composite liner. Frequently, landfill designers and operators will install a double liner system in MSW landfills to provide additional monitoring capabilities for the environment and the community.

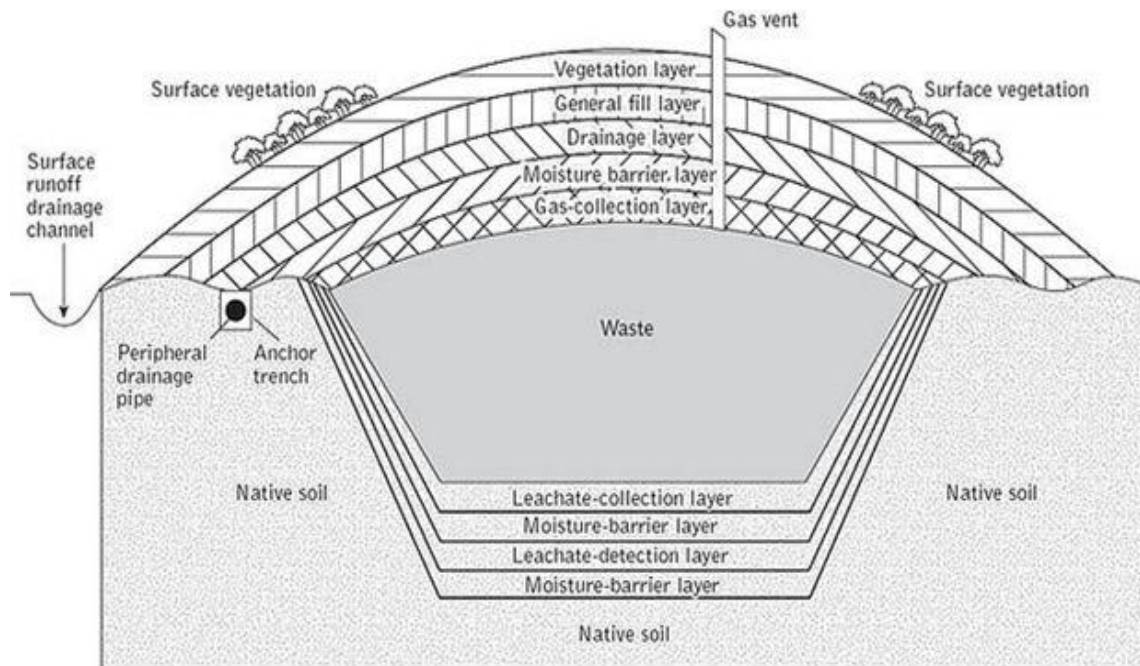
02 M For
Explain-
ation02 M For
Diagram

OR

Double-Liner Systems

- A double liner consists of either two single liners, two composite liners, or a single and a composite liner.
- The upper (primary) liner usually functions to collect the leachate, while the lower (secondary) liner acts as a leak-detection system and backup to the primary liner.
- Double-liner systems are used in some municipal solid waste landfills and in all hazardous waste landfills.
- Hazardous waste landfills also referred to as secure landfills are constructed for the disposal of wastes that once were ignitable, corrosive, reactive, toxic, or are designated as hazardous.
- These wastes can have an adverse effect on human health and the environment, if improperly managed.
- Hazardous wastes are produced by industrial, commercial, and agricultural activities.
- Hazardous wastes must be disposed of in hazardous waste landfills. Hazardous waste landfills must have a double liner system with a leachate collection system above the primary composite liner and a leak detection system above the secondary composite liner.

02 M For
Explain-
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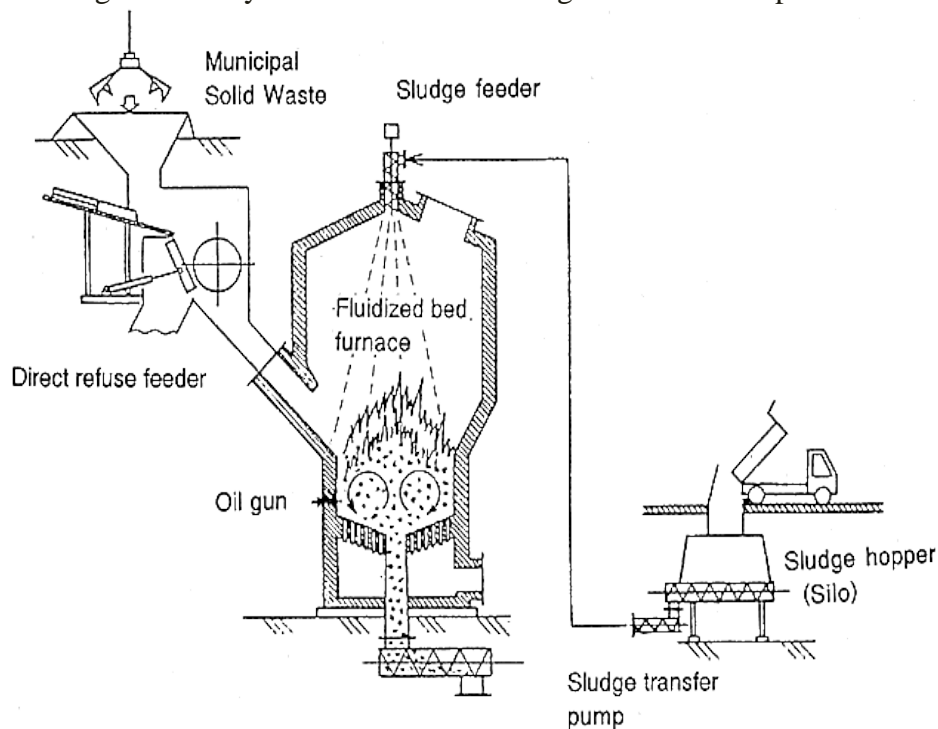
02 M For Diagram

e) Describe the working of a municipal incinerator.

04M

- Incineration is a waste treatment process that involves the combustion of solid waste at 1000°C.
- Waste materials are converted into ash, flue gas, and heat.
- The ash is mostly formed by the inorganic constituents of the waste and gases due to organic waste.
- The heat generated by incineration is used to generate electric power.

02 M For Explanation



02 M For Diagram

Municipal incinerator

	SOLUTION	MARKS														
Q .NO 5	Attempt ANY FOUR of following: (04x04)	16 M														
a)	Describe provisions in the law for safe disposal of biomedical waste.	04 M														
	<p>➤ Disposal of biomedical waste is now a legal requirement in India. The ministry of environment and forests notified the bio medical waste rules, 1998 in July 1998. In accordance with these rules following provisions are made:</p> <p>➤ It is the duty of every occupier i.e. a person who has the control over the institution or its premises, to take all steps to ensure that waste generated is handled without any adverse effect to human health and environment.</p> <p>➤ The hospitals, nursing homes, clinics, dispensaries, pathological laboratories etc. are therefore required to set in places the biological waste treatment facilities.</p> <p>➤ Bio medical waste rules have six schedules as briefed in table.</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th style="text-align: center;">Schedule</th> <th style="text-align: center;">Contents</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Schedule I</td> <td>Classification of biological waste in various categories</td> </tr> <tr> <td style="text-align: center;">ScheduleII</td> <td>Color coding ant types of containers to be used for each category of biomedical waste</td> </tr> <tr> <td style="text-align: center;">ScheduleIII</td> <td>Proforma of the label to be used on container/bag</td> </tr> <tr> <td style="text-align: center;">ScheduleIV</td> <td>Proforma of label for transport of waste container/ bag</td> </tr> <tr> <td style="text-align: center;">Schedule V</td> <td>Standards for treatment and disposal of waste</td> </tr> <tr> <td style="text-align: center;">Schedule VI</td> <td>Deadline for creation of waste treatment facilities</td> </tr> </tbody> </table>	Schedule	Contents	Schedule I	Classification of biological waste in various categories	ScheduleII	Color coding ant types of containers to be used for each category of biomedical waste	ScheduleIII	Proforma of the label to be used on container/bag	ScheduleIV	Proforma of label for transport of waste container/ bag	Schedule V	Standards for treatment and disposal of waste	Schedule VI	Deadline for creation of waste treatment facilities	04 M
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b)	What are the components of biomedical waste?	04 M														
	<p>Following are the components of biomedical waste:</p> <ol style="list-style-type: none"> 1) Human anatomical waste (tissues, organ, body parts etc) 2) Animal waste (as above, generated during research/ experimentation, from veterinary hospital etc) 3) Microbiological and biotechnological waste such as laboratory cultures, microorganisms, human and animal cell cultures, toxins etc. 4) Waste sharps, such as hypodermic needles, syringes, scalpels, broken glass etc. 5) Discarded medicines and cyto-toxic drugs. 6) Soiled waste such as dressing, bandages, plaster casts, material contaminated with blood etc. 7) Solid waste (disposal items like tubes, catheters etc excluding sharps) 8) Liquid waste generated from any of the infected area. 9) Incineration ash 10) Chemical waste 	(1/2 mark for each point) <u>Write any Eight</u>														

Q .NO	SOLUTION	MARKS
c)	What are ill effects of hazardous substances that come out of E- Waste?	04
	<p>Following are ill effect of hazardous substances that come out of E-waste:</p> <ol style="list-style-type: none"> 1) Mercury causes chronic damage to the brain, memory loss, and muscle weakness. 2) Sulphur causes liver damage, kidney damage, heart damage, and eye and throat irritation. 3) Cadmium causes neutral damage, toxic irreversible effects on human health. 4) BFRs disrupt endocrine system function. 5) Lead damage to central and peripheral nervous systems, blood systems and kidney damage. 6) Lead affects the brain development of children. 7) Cadmium also accumulates in kidney and liver, teratogenic. 8) The inhalation of cadmium can cause severe damage to the lungs and also causes kidney damage. 	<p>(1 mark for each point) <u>Write any Four</u></p>
d)	Describe disposal method of E-waste.	04
	<p>Disposal of E-waste is done by following four method:</p> <ol style="list-style-type: none"> 1) Land filling: In land filling, trenches are made on the flat surfaces. Soil is excavated from the trenches and waste material is buried in it, which is covered by thick layer of soil. Now a day's secure land filling are provided with some facilities like impervious liner made up of plastic or clay, leachate collection basin that collect and transfer the leachate to wastewater treatment plant. Environmental risk from land filling of e-waste cannot be neglected because the condition of land filling site are different from a native soil, particularly concerning the leaching behavior of metals. 2) Incineration: It is controlled and complete combustion process, in which the waste material is burned in specially designed incinerators at a high temperature. Advantage of incineration of e-waste are the reduction of waste volume and utilization of the energy content of combustible materials. Disadvantages of incineration are the emission to air of substances escaping flue gas cleaning and the large amount of residue from gas cleaning and combustion. 3) Recycling of e-waste: Monitors and CRT, keyboards, laptops, modems, telephone bards, hard drives, floppy drives, compact disk, mobiles, fax machines, printers, CPUs, memory chips, connecting wires and cables can be recycled. Recycling involves dismantling and recovery of valuable materials. Recycling is the best possible option for the management of e- waste because the existing dumping grounds in India are full and overflowing beyond capacity and it is difficult to get new dumping sites due to Scarcity of land. 4) Re-use: It is commonly used for electronic equipments like computers, cell phones etc. It constitutes direct second hand use or use after slight modification to the original functioning equipment. This method also reduces the volume of e-waste generation. 	<p>2 mark for any Two Methods</p>

Q .NO	SOLUTION		MARKS															
e)	Describe the waste minimization approach measures of industrial waste.		04 M															
	<ul style="list-style-type: none"> ➤ Optimization of resources: waste reduction at individual and institutional level goes side by side with the utilization of raw materials. ➤ Using again the Scrap Material: this is the process in which individual and ➤ Industry reuses the waste material as soon as it is produced. This keeps it from becoming a waste material. ➤ Quality control improvement and process monitoring: this technique is to ensure that products produced are kept from rejection and this is increased by the inspection of frequency and monitoring point's inspection. ➤ Exchanging Waste: this is the technique in which the waste product, which comes out of a process, becomes a raw material for another process. This is another way for reducing waste. ➤ Point of use from ship: to maintain and making deliveries for the raw materials to be used with the manufacturing process, at the point of assembly with fewer packages and wrappings can save from the waste production. ➤ Zero waste: this is a whole systems approach that aims to eliminate waste at the source and at all points down the supply chain, with the intention of producing no waste. It is a design philosophy which emphasizes waste prevention as opposed to end of pipe waste management. 		04 M															
f)	Describe recycling of any four industrial wastes.		04 M															
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Q .NO	SOLUTION	MARKS
Q No-6	Attempt any FOUR of the following:	16 M
a)	Describe the strategy of public participation in solid waste management.	04 M
	<p>The following strategy may be adopted by the urban local bodies:</p> <p>Identification of Peoples Groups: Community may be classified into three categories:</p> <ol style="list-style-type: none"> 1. High Income Group: The affording 2. Middle Income Group: Educated, sensitive, less affording. 3. Low Income Group: Un-affording <p>Sensitivity of each group is different and therefore needs to be tackled differently.</p> <p>Markets/ Commercial Areas/ Offices/Banks etc: These places may be classified into three broad categories:</p> <ol style="list-style-type: none"> 1. Vegetables market 2. Shopping Areas 3. Offices/ Institutional areas. <p>Identification of Problems: Identification of problems of waste management through sites visits and consultation with local population at the time when the community is generally available for interaction.</p> <p>Peoples Participation is essential in the following areas:</p> <ul style="list-style-type: none"> ➤ Reduce Reuse and Recycling of waste. ➤ Not to throw the waste / litter on the streets, drains, open spaces, water bodies etc. ➤ Primary collection of waste. ➤ Managing excreta of pet dogs and cats appropriately. ➤ Pay adequately for the services provided. <p>Finding out Optional Solutions: Having identified the deficiencies in the systems and known the public perceptions, the next essential steps are to think of optional solutions to tackle the problems, workout the cost implications and level of public participation needed.</p> <p><i>(Note: Student may Write any appropriate explanation so credit may be given accordingly.)</i></p>	04 M
b)	What are the measures to be taken to bring about a change in public?	04 M
	<p>The following measures are therefore proposed to be taken to reduce, reuse, and recycling of waste by all concerned:</p> <ol style="list-style-type: none"> 1. All manufactured producing a variety of domestic and non-domestic products, food as well as non- food should be persuaded to seriously Endeavour to use re-useable packaging materials so that after the delivery of goods, the packaging materials could be collected back and used over and over again. They could also consider minimizing or avoiding use of unnecessary packaging material by innovative method. 2. Incentives and product discount should be given to consumers for the return of packaging or bottling material in good condition, to the waste producers or retailers to promote reuse. 	04 M

Q .NO	SOLUTION	MARKS
	<p>3. The cost of packed articles and article without the packaging material could be kept different with a choice to the consumers to take the article without the packaging material at low cost.</p> <p>4. One person’s waste material can be useful material for others. All such material is collected through waste collectors, waste producers, NGOs and private sectors etc. and can be reused.</p> <p>5. Excessive packaging material being used, a lot of recyclable waste is generated,. All such material are retrieve from households, shops and establishments and fed to the recycling industries through intermediaries such as waste purchasers, waste collectors/ NGOs etc.</p> <p>6. Participation of public in primary collection of waste.</p> <p>7. Use of community bins wherever directed.</p> <p>8. Storage of wet food/ bio-degradable waste and dry recyclable waste separately at source.</p> <p><i>(Note: Student may Write any appropriate explanation so credit may be given accordingly.)</i></p>	
c)	<p>Describe the health aspects involved in handling and processing of solid waste.</p>	<p>04 M</p>
	<p>Health aspects involved in handling and processing of solid waste:</p> <ul style="list-style-type: none"> ➤ There is potential risk to environment and health from improper handling of solid wastes. Direct health risks concern mainly the workers in this field, who need to be protected, as far as possible, from contact with waste. ➤ Traffic accidents can result from toxic spilled wastes. ➤ Air pollution can be caused from the inefficient burning of wastes, either in open air, or in plants that lack effective treatment facilities from the gaseous effluents. ➤ Uncontrolled hazardous wastes from industries mixing up with municipal wastes create potential risk to human health. ➤ The most obvious environmental damage caused by municipal solid wastes is aesthetic, the ugliness of street litter and degradation of urban environment and beauty of city. ➤ There is specific danger of concentration of heavy metals in the food chain, a problem that illustrates the relationship between municipal solid wastes and liquid industrial effluents containing heavy metals discharged to a drainage/ sewerage system and/ or open dumping sites of municipal solid wastes and the wastes discharged thereby maintains a vicious cycle. ➤ Municipal Solid Wastes Management Systems involves various activities like storage, collection, transportation, disposal etc. These activities even if properly controlled and with proper precautionary measures adopted, may have adverse impact on land, water and air environment, human and environmental health aesthetics and quality of life. ➤ The main risk to health is indirect and arises from the breeding of disease vectors, primarily flies and rats. 	<p>(1 mark for each point) <u>Write any Four</u></p>

Q.NO	SOLUTION	MARKS
d)	<p>Describe thermal processes of resources recovery through waste processing.</p> <p>Thermal processes: Thermal treatment involves conversion of waste into gaseous, solids and liquid conversion products with subsequent release of heat energy.</p> <p>Three types of systems are as follows:</p> <ul style="list-style-type: none"> i) Combustion systems: Thermal processing with excess amounts of air. ii) Pyrolysis systems: Thermal processing in complete absences of oxygen. iii) Gasification systems: Thermal processing with less amounts of air. <p>Combustion systems are the most widely adopted thermal treatment process worldwide for MSW. Though Pyrolysis is a widely used industrial process, the Pyrolysis of municipal solid waste has not been very successful.</p> <p>Three types of combustion systems have been extensively used for energy recovery in different countries namely: mass- fired combustion systems, Refused Derived Fuel (RDF), fired combustion systems and fluidized bed combustion systems are mostly used.</p> <p>To be viable for energy recovery through thermal processing, the municipal solid waste must possess a relatively high calorific value. In the MSW generated in developed countries, presences of significant quantity of paper and plastic yields a high calorific value of the MSW which makes it suitable for thermal processing.</p> <p>In Indian MSW, the near absence of paper and plastic as well as the presences of high quantities of inert material, all combine to yield a low calorific value of the MSW. In its mixed form, such waste may not be suitable for thermal processing.</p> <p>Removal of inert from Indian MSW as well as development of combustion system for low- calorific value wastes can result in a reversal of this position in future.</p> <p><i>Note-: (Resource recovering is nothing but recycling practice so if student write about recycling appropriate credit may be given accordingly.)</i></p>	<p>04 M</p> <p>04 M</p>
e)	<p>What are benefits of recycling?</p> <ul style="list-style-type: none"> ➤ Reduces the amount of waste sent to landfills and incinerators. ➤ Conserves natural resources such as timber, water and minerals. ➤ Saves energy. ➤ Prevents pollution by reducing the need to collect new raw materials. ➤ Helps sustain the environment for future generations. ➤ Reduce greenhouse gas emissions that contribute to global climate change. 	<p>04M</p> <p>1 Mark for Each</p>

Q .NO	SOLUTION	MARKS
f)	Describe methods of collection of recyclables.	04
	<p>Following are the methods of collection of recyclables:</p> <p><u>1.Curbside Collection:</u></p> <ul style="list-style-type: none"> ➤ Curbside Collection, or curbside collection, is a service provided to households, typically in urban and suburban areas, of removing household waste. ➤ A curbside collection of recyclable material is a method of collection whereby the resident sorts their domestic waste according to type of material. ➤ This is collected in the household in specially provided bins. The bins are then placed on the kerb side or nearest collection point outside the property by the householder on a fortnightly basis. <p><u>2.Buy-back Centers :</u></p> <ul style="list-style-type: none"> ➤ When it comes to Buy-back Centers, the recyclers are similarly required to bring the recyclables to a central location. However, at the Buy-back Centers, the Cleaned recyclates are purchased from the recyclers. ➤ This method of recycling waste collection provides an incentive for recyclers to send their used items for recycling, hence ensuring a stable supply of recyclables. ➤ In turn, the post-processed materials are then sold, hopefully with a profit. Given that the resale value of post-processed materials may sometimes be lower than the processing cost, government subsidies may be required for the system of Buy-back Centers to be viable. <p><u>3.Drop-off Centers:</u></p> <ul style="list-style-type: none"> ➤ These centers require the recyclers (e.g. the homemaker) to bring the recyclables to a central location, either an installed or mobile collection station or the reprocessing plant itself. ➤ This form of recycling waste collection is the easiest to establish. However, since the use of such centers is on a voluntary basis, it often suffers from Low and unpredictable supply of recyclables. <p><u>4.Deposit Programs:</u></p> <ul style="list-style-type: none"> ➤ Customers pay an additional fee when purchasing beverage containers but receive fee back once they return the container to the purchase point. ➤ As an incentive, the deposit beverage Container Program places a certain amount as redeemable deposit on each beverage container. ➤ Consumers get back their amount when they return their containers to a redemption Centre. 	<p>2 mark for any Two Methods</p>