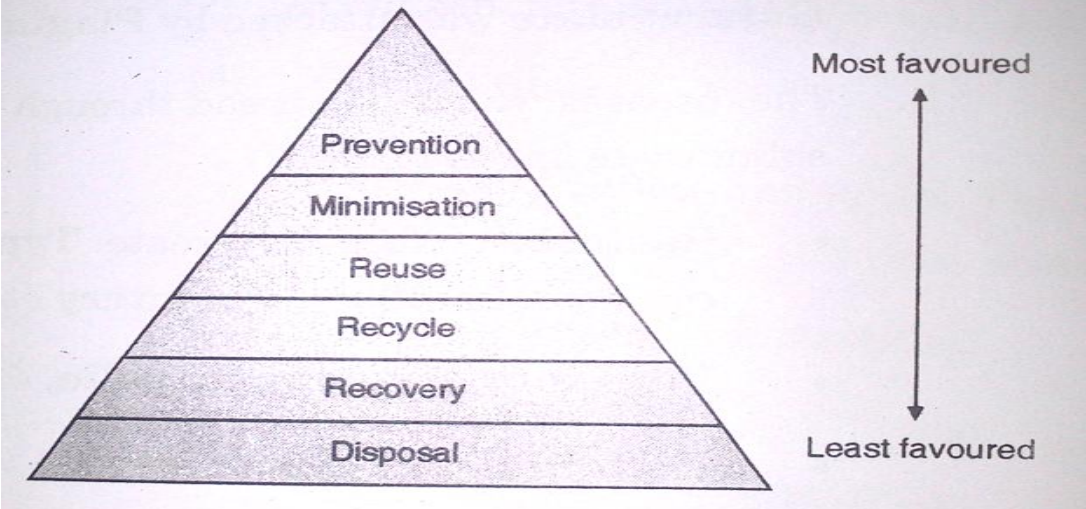


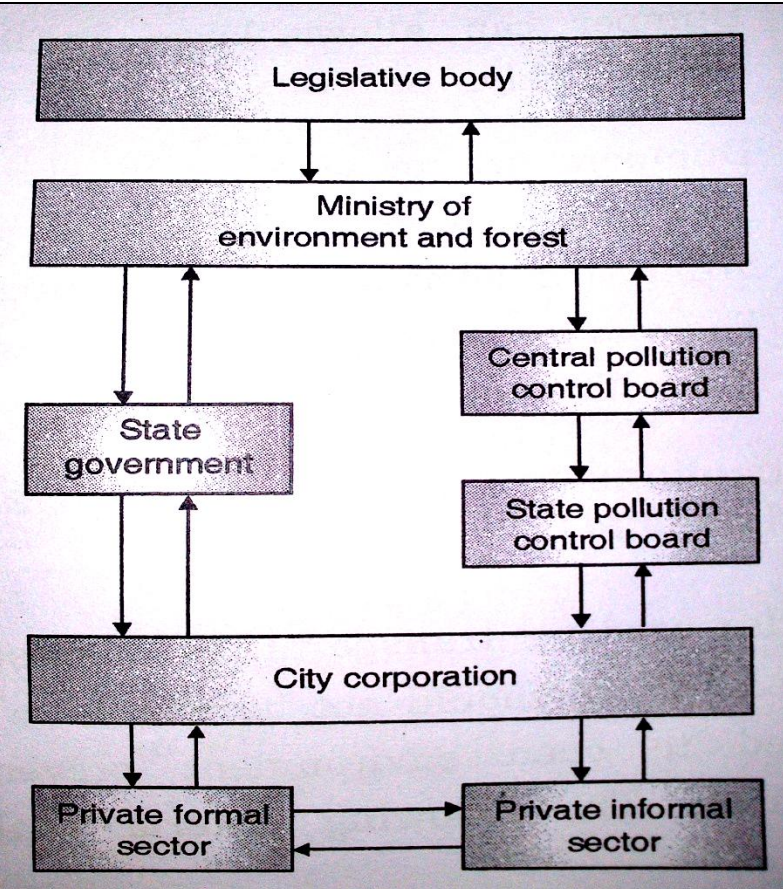
Important Instruction to Examiners:-

- 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) There is alternate solution is provided for Q-3(a). The examiner may give credit according to that.**

Q .NO	SOLUTION	MARKS
Q1. a)	Attempt ANY SIX of following: (06 x 02)	12
(i)	State physical characteristics of solid waste. Explain any one.	02
	<p><u>Physical characteristics of solid waste:</u></p> <ol style="list-style-type: none"> 1. Specific weight or weight of waste per unit volume. 2. Particle size and size distribution 3. Field capacity/percentage of moisture in wet solid. <p><u>Field capacity:</u> It is defined as total amount of moisture held in a waste matter under gravity. It is important as it controls the rate of leachate generation and permeability. <i>(Note: Student may Wright any appropriate explanation so credit may be given accordingly.)</i></p>	<p>½ each</p> <p>½ for explanation</p>
(ii)	Explain solid waste management hierarchy.	02
	<div style="text-align: center;">  <p>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. 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. </div>	<p>1 for neat labeled sketch</p> <p>¼ for each (Any four)</p>

Q .NO	SOLUTION	MARKS
(iii)	State factors affecting selection of site for transfer station.	02
	Factors affecting selection of site for transfer station: <ol style="list-style-type: none"> 1. <u>Waste scattering/ Pollution:</u> It should be selected such that it should not create nuisance to nearby areas. 2. <u>Haul distance:</u> It should be constructed at suitable locations so as to minimize the haul distance. 3. <u>Electricity:</u> Electricity should be available. 4. It should be away from heritage place. 	1 marks each
(iv)	State organizational setup of Solid waste Management (SWM) administration for city having population between 5-10 lacs.	02
	 <p style="text-align: center;">Organizational setup of Solid waste Management (SWM) administration</p> <pre> graph TD LB[Legislative body] <--> ME[Ministry of environment and forest] ME <--> SG[State government] ME <--> CPCB[Central pollution control board] SG <--> CC[City corporation] CPCB <--> SPCB[State pollution control board] SPCB <--> CC CC <--> PFS[Private formal sector] CC <--> PIS[Private informal sector] PFS <--> PIS </pre>	2 for neat labeled sketch
(v)	Define biomedical waste. State components of Biomedical Waste (BMW).	02
	<p><u>Biomedical waste:</u> “The waste generated by hospitals, nursing or maternity homes, clinics, dispensary, veterinary institutions, pathological laboratory, blood banks which is potentially infectious to human health and the environment is called as Biomedical waste.”</p> <p><u>Components of Biomedical Waste:</u></p> <ol style="list-style-type: none"> 1. Sharps: needles, broken glass, blades, razors etc. 2. Plastic waste: IV sets, tubing, blood & urine bags, syringes. 3. Infectious waste: soiled bandages, dressings, pathological tissues. 4. Cytotoxic waste 5. Chemical waste 6. Radioactive waste etc. 	1 ¼ each (Any four)

Q .NO	SOLUTION	MARKS
(vi)	Enlist sources of Biomedical waste	02
	<p>Following are the sources of Biomedical waste:</p> <ol style="list-style-type: none"> 1. Waste generated by Hospitals 2. Waste generated by nursing homes 3. Waste generated by clinics 4. Waste generated by pharmacies 5. Waste generated by pathological laboratory 6. Waste generated by blood banks 7. Waste generated by medical research laboratory. 8. Waste generated by funeral homes etc. 	½ marks each (Any four)
(vii)	Define communicable and non-communicable diseases.	02
	<p><u>Communicable diseases:</u> The diseases that spread from one person to another through airborne bacteria or viruses or through direct contact with infected person.</p> <p><u>Non-communicable diseases:</u> The diseases that cannot transmitted from infected person to other person through air, water or direct contact and hence are non infectious.</p>	1 1
(viii)	Explain sorting at source and (MSW) Municipal Solid Waste.	02
	<p><u>Sorting at Source:</u> It is the most efficient technique that reduces the mixing of various biodegradable and non biodegradable wastes together. In this process different types of wastes are stored in different containers like plastic waste, biodegradable waste, E-waste, Glass, Paper, etc. Based on the nature of waste collected appropriate treatment is given, which automatically reduces the time and cost of treatment.</p> <p><u>Municipal Solid Waste:</u> It is the waste collected from various sources like household, institutions, commercial centers, etc. and then taken to the nearest transfer stations, which after transferred to Municipal Solid Waste Plants by hauling vehicles for further treatment.</p>	1 1
b)	Attempt any TWO of the following: (04 x 02 = 08)	08
(i)	State the factors affecting generation of MSW	04
	<p><u>Factors affecting generation of MSW:</u></p> <ol style="list-style-type: none"> 1. Living standard 2. Rate of generation of waste 3. Population growth 4. Improper guidance 5. Lack of awareness 6. Industrialization growth etc. 	1 each (Any four)
(ii)	Define transfer station. State necessity of transfer station.	04
	<p><u>Transfer station:</u> 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><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. 4. To reduce the haul distance. 	1 1 each (Any 3)

Q.NO	SOLUTION	MARKS
(iii)	State biomedical waste rules having six schedules and their content	04
	<u>Rules for BMW:</u> <ol style="list-style-type: none"> 1. Rules for duty of occupier. 2. Rules for treatment and disposal. 3. Rules for segregation, packaging, transportation and storage. 4. Rules for prescribed authority. 5. Rules for authorization. 6. Rules for advisory committee. 7. Rules for annual report. 8. Rules for maintenance of records. 9. Rules for accident reporting. 10. Rules for appeal.etc 	½ each (Any 8)
Q.02	Attempt ANY FOUR of the following: (04 x 04 = 16)	16
a)	State factors affecting composting process. Explain any one factor.	04
	<u>Factors affecting composting process:</u> <ol style="list-style-type: none"> 1. Particle size 2. Moisture content 3. pH 4. Temperature 5. Carbon Nitrogen ratio 6. Blending and seeding 7. Air circulation <p><u>Blending and seeding:</u> It is required to maintain the moisture content and to accelerate biological decomposition of waste and hence affect the rate of composting. Proper timing should be followed for blending and seeding.</p> <p>(Note: Student may Wright any appropriate explanation for <u>Any factor</u> so credit may be given accordingly.)</p>	½ for each (Any Four) 2 for explanation
b)	State the factors affecting selection of site for land filling of solid waste.	04
	<u>Factors affecting selection of site for land filling of solid waste:</u> <ol style="list-style-type: none"> 1. Site should be easily approachable. 2. It should be located away from community area. 3. Sufficient quantity of soil should be available nearby site. 4. Waterlogged and flood prone areas should be avoided. 5. Local climate should be considered while selecting site for land filling. 6. Ground water should be very deep; it should not be less than 5m. <p>(Note: Student may Wright any appropriate explanation for <u>Any factor</u> so credit may be given accordingly.)</p>	1 each (Any four)
c)	Explain use and byproduct of incineration method of solid waste (SW).	04
	<u>Use and byproduct of incineration method of solid waste:</u> <ol style="list-style-type: none"> 1. After the incineration process the left out products can be used as aggregate for preparation of low grade concrete or even sometimes it can also be used as road metal. 2. The incineration ash is used for making bricks or block manufacturing. 3. Also the steam generated during incineration can be used for electricity generation by running the turbines. 4. The products of incineration can also be used as filler material. <p>(Note: Student may Wright any appropriate explanation for <u>Any factor</u> so credit may be given accordingly.)</p>	1 each

Q .NO	SOLUTION	MARKS																																
	<p>In Buy back centers, the clean recyclables are purchased thus providing a clear incentive for use and creating a stable supply. In curbside collection method bins are placed at curbside for collection. In Single stream collection, all recyclable materials are placed in a single bin for collection and sorting which is handled later at a central facility.</p>																																	
<p>Q-3</p> <p>a)</p>	<p>Attempt <u>ANY TWO</u> of the following: (08x 02 = 16)</p> <p>i) Principles of composting of Solid Waste. Composting is the biological decomposition of organic waste such as food or plant material by bacteria, fungi, worms and other organisms under controlled aerobic (occurring in the presence of oxygen) conditions. The end result of composting is an accumulation of partially decayed organic matter called humus.</p> <p>ii) Differentiate between Indore and Bangalore method with sketch.</p> <table border="1" data-bbox="272 678 1369 1402"> <thead> <tr> <th data-bbox="272 678 347 720">No.</th> <th data-bbox="347 678 821 720">Bangalore method</th> <th data-bbox="821 678 896 720">No</th> <th data-bbox="896 678 1369 720">Indore method</th> </tr> </thead> <tbody> <tr> <td data-bbox="272 720 347 932">1</td> <td data-bbox="347 720 821 932">The Bangalore method functions aerobically for several days and then becomes anaerobic, because no turning occurs.</td> <td data-bbox="821 720 896 932">1</td> <td data-bbox="896 720 1369 932">The Indore composting system relies on aerobic activity although portions of the pile or pit will likely become anaerobic between turnings.</td> </tr> <tr> <td data-bbox="272 932 347 1060">2</td> <td data-bbox="347 932 821 1060">Fly breeding and odor problems are often associated with this method</td> <td data-bbox="821 932 896 1060">2</td> <td data-bbox="896 932 1369 1060">This method has better fly control.</td> </tr> <tr> <td data-bbox="272 1060 347 1102">3</td> <td data-bbox="347 1060 821 1102">Slow method</td> <td data-bbox="821 1060 896 1102">3</td> <td data-bbox="896 1060 1369 1102">more rapid</td> </tr> <tr> <td data-bbox="272 1102 347 1144">4</td> <td data-bbox="347 1102 821 1144">Non-uniform decomposition</td> <td data-bbox="821 1102 896 1144">4</td> <td data-bbox="896 1102 1369 1144">uniform decomposition</td> </tr> <tr> <td data-bbox="272 1144 347 1318">5</td> <td data-bbox="347 1144 821 1318">After 4 to 5 months the composting process is complete.</td> <td data-bbox="821 1144 896 1318">5</td> <td data-bbox="896 1144 1369 1318">During the period of active composting the contents are turned from 1-5 times over a period of 16 months.</td> </tr> <tr> <td data-bbox="272 1318 347 1360">6</td> <td data-bbox="347 1318 821 1360">More labor intensive method.</td> <td data-bbox="821 1318 896 1360">6</td> <td data-bbox="896 1318 1369 1360">Less labor intensive method.</td> </tr> <tr> <td data-bbox="272 1360 347 1402">7</td> <td data-bbox="347 1360 821 1402">moisture control problems</td> <td data-bbox="821 1360 896 1402">7</td> <td data-bbox="896 1360 1369 1402">less moisture control problems</td> </tr> </tbody> </table> <p style="text-align: center;">Alternate Solution for Q-3 (a)</p> <p style="text-align: center;">OR</p> <p>I) Indore method</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. 	No.	Bangalore method	No	Indore method	1	The Bangalore method functions aerobically for several days and then becomes anaerobic, because no turning occurs.	1	The Indore composting system relies on aerobic activity although portions of the pile or pit will likely become anaerobic between turnings.	2	Fly breeding and odor problems are often associated with this method	2	This method has better fly control.	3	Slow method	3	more rapid	4	Non-uniform decomposition	4	uniform decomposition	5	After 4 to 5 months the composting process is complete.	5	During the period of active composting the contents are turned from 1-5 times over a period of 16 months.	6	More labor intensive method.	6	Less labor intensive method.	7	moisture control problems	7	less moisture control problems	<p>2 Marks</p> <p>1 Marks for Each Point (Any Six)</p> <p>4 Marks</p>
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Q .NO	SOLUTION	MARKS
b)	<ul style="list-style-type: none"> ➤ 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>II) Bangalore method</p> <ul style="list-style-type: none"> ➤ Bangalore method is commonly 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. 	4 Marks
	<p>i) Definition Leachate is any liquid that in passing through matter, extracts solutes, suspended solids or any other component of the material through which it has passed.</p> <p>ii) Effect of Leachate</p> <ul style="list-style-type: none"> ➤ Problems including clogging with mud or silt. ➤ growth of micro-organisms in the conduit ➤ The chemical composition of leachate can weaken pipe walls, which may then fail. ➤ The percolation of leachate will cause the soil pollution ➤ Lechate will also contaminate the shallow ground water source in rainy season. ➤ It affect the DO Content water which is harmful for aquatic life ➤ It will leads to the growth of waterborne diseases. <p>iii) Control measures.</p> <ul style="list-style-type: none"> ➤ Leachate is carefully collected and shall be treated before its release on ground if possible. ➤ Prevention of migration of leachate from landfill sides and landfill base to the sub-soil by a suitable liner system should be provided. ➤ used leachate treatment methods like Natural system, Biological treatment Physicochemical treatment 	
c)	<p>i) Principles of Pyrolysis Pyrolysis is the one of the most common methods in thermal conversion technology of biomass. In Pyrolysis, biomass is heated to moderate temperatures, 400-600°C, In the absence of oxygen to produce oil. In gasification, biomass is heated to high temperatures, >700°C, to produce a synthesis gas(H₂ and CO), which can be converted in a catalytic step to liquid transportation fuels.</p>	2 Marks

Q .NO	SOLUTION	MARKS
	<p>Types of solid waste:</p> <ul style="list-style-type: none"> ➤ Municipal Waste ➤ Hazardous Waste ➤ Biomedical Waste ➤ Electronic Waste 	2 Marks (1/2 marks for each write any four points)
b	<p>Explain four characteristics of hazardous waste.</p> <p>1. Ignitability - Ignitable wastes create fires under certain conditions or are Spontaneously combustible, or have a flash point less than 60 °C (140 °F).</p> <p>2. Corrosivity - Corrosive wastes are acids or bases (pH less than or equal to 2 or greater than or equal to 12.5) that are capable of corroding metal containers, such as storage tanks, drums, and barrels.</p> <p>3. Reactivity - Reactive wastes are unstable under "normal" conditions. They can cause explosions, toxic fumes, gases, or vapors when mixed with water.</p> <p>4. Toxicity - Toxic wastes are harmful or fatal when ingested or absorbed (e.g., containing mercury, lead, etc.). When toxic wastes are disposed of on land, contaminated liquid may drain (leach) from the waste and pollute ground water. Toxicity is defined through a laboratory procedure called the Toxicity Characteristic Leaching Procedure.</p>	4 Marks (1 Marks each)
c	<p>Explain issues regarding transportation of solid waste.</p> <ul style="list-style-type: none"> ➤ Compactors and properly covered dump trucks were to be utilized to transport the waste to the landfill site. ➤ Separate vehicles were to be employed for transportation of biodegradable waste and mixed recyclable waste. ➤ Compactor loaders directly lift the bin, unload the waste and replace it in the original position. ➤ Choice of vehicle depends on the access roads to individual sites. <p>Dump trucks are fitted with hydraulic equipments which enable them to unload waste without the help of manual labour.</p> <p><i>(Note: Student may Wright any appropriate explanation so credit may be given accordingly.)</i></p>	4 Marks
d	<p>Enlist tools and equipment for collection and transportation of a solid waste.</p> <ol style="list-style-type: none"> 1. Litter bin 2. Broom 3. Shovels 4. Handcarts 5. Animal carts 6. Tractors and Trailers 7. Auto vehicle 8. Trucks. 9. Dumper 10. Compactors vehicles. 	1/2 Marks For Each write any 8 point

Q .NO	SOLUTION	MARKS
e	<p>As a civil engineer how will you promote four R (4R) principle of SWM.</p> <ol style="list-style-type: none"> Reduction: Waste reduction can be achieved in three ways: i) reducing the amount of material used per product without sacrificing the utility of that product. ii) Increase lifetime of a product. iii) Eliminating the need of the product. To reduce waste we usually have to make significant lifestyle changes. Reduce office paper waste by implementing a formal policy to duplex all draft reports and by making training manuals and personnel information available electronically. Improve product design to use less material. Switch to reusable transport containers Reuse: Reuse corrugated moving boxes internally. Encourage employees to reuse office materials rather than purchase new ones. Recycle: Recycling turns the material that would otherwise become waste into valuable resources and generates a combination of environmental, financial and social benefits. After collection of these materials (eg. Glass, metal, plastics, paper etc.) are separated and sent to facilitates that can process them into new products and materials. Recovery: Recovery of solid waste means recovering material from solid waste to useful purposes. Composting is a way to return nutrient back into the environment by allowing micro organisms to turn the waste into manure. 	4 Marks (1 Mark each point)
f	<p>Explain resource recovery through solid waste processing.</p> <p>Biological and thermal treatment of waste can result in recovery of useful product such as energy or compost.</p> <p>Biological Processes: In this treatment involves using micro-organisms to decompose the biodegradable components of waste. Two types of process are use:</p> <ol style="list-style-type: none"> Aerobic processes: Windrow composting, aerated static pile composting and in vessel composting, vermiculture etc. Utilizable product is compost. Anaerobic processes: Low solids anaerobic digestion, high solids anaerobic digestion. Utilizable product is methane gas. <p>In India, aerobic composting plants have been used to process up to 500 tons per day of waste.</p> <p>Thermal processes: Thermal treatment involves conversion of waste into gaseous, solids and liquid conversion products with subsequent release of heat energy. Three types of systems are as follows:</p> <ol style="list-style-type: none"> Combustion systems: Thermal processing with excess amounts of air. Pyrolysis systems: Thermal processing in complete absences of oxygen. Gasification systems: Thermal processing with less amounts of air. <p>Note-: (Resource recovering is nothing but recycling practice so if student write about recycling appropriate credit may be given accordingly.)</p>	4 Marks

Q .NO	SOLUTION	MARKS
Q.6 a)	<p>Attempt <u>ANY FOUR</u> of the following: (04 x 04 = 16)</p> <p>Explain proximate analysis of solid waste. Determination of fixed carbon, volatile combustible matter, moisture and ash content of the Waste in order to estimate its capability as a fuel. -The fixed carbon, volatile combustible matter can be burnt while moisture and ash not. The Vaporization of the moisture consumes heat. Method of analysis (tests): 1. Moisture: Determination from the loss of weight by heating at 105 °C for one hour. 2. Volatile combustible matter: the additional loss of weight after ignition at 950 °C in a Covered crucible (O₂ is excluded). 3. Fixed carbon: combustible residue after the volatile combustible matter is removed; ignition At 600 to 900 °C. 4. Ash: the weight of residue after combustion in an open crucible. % fixed carbon=100 %-% moisture -% ash-% volatile matter It does not provide any information of possible pollutants emitted during combustion. These data are determined by ultimate analysis.</p>	4 Marks (1 Mark for each)
b	<p>Described impact of solid waste on human health and environment</p> <p><u>Impacts of solid waste on health</u></p> <ul style="list-style-type: none"> ➤ Low birth weight ➤ Cancer ➤ Neurological disease ➤ Increase in mercury level in fish due to disposal of mercury in the rivers. This is Harmful for human health. ➤ Chemical poisoning through chemical inhalation. ➤ Nausea and vomiting ➤ Increase in hospitalization of diabetic resident living near waste site <p><u>Impacts of solid waste on Environment.</u></p> <ul style="list-style-type: none"> ➤ Waste breaks down in landfills to form methane, which causes greenhouse gas. ➤ Change in climate and destruction of ozone layer due to waste biodegradable <p>Due to waste pollutions, illegal dumping, Leaching: is a process by which solid waste enter soil and ground water and contaminating them</p>	2 Marks (1/2 marks for each write any four points 2 Marks (1/2 marks for each write any four points
c	<p>Explain present scenario of collection of MSW.</p> <ul style="list-style-type: none"> ➤ No bins for storage of domestic, trade or institutional waste are kept at source. Very few people keep personal bins for storage of waste. The percentage of these people is very insignificant. ➤ Most of the situations domestic waste as well as waste from shops, offices and establishment including hospitals, nursing homes, hotels, restaurants, garden etc. come on the street or is disposed of open plot or even discharge in the drains. Its result is clogging of drains, pollution of water resources and increasing insanitary condition in urban areas. ➤ Hence there is no practice of storing the waste at sources in scientifically segregated way. ➤ Citizens have not been educated to keep domestic, trade and institutional bins for storage of waste at source. <p>(Note: Student may Wright any appropriate explanation so credit may be given accordingly.)</p>	4 Marks

Q .NO	SOLUTION	MARKS
	<ul style="list-style-type: none">➤ Material recycling is done through sorting of waste into different streams at source or at a centralized facility. At present recycling of dry recyclables does take place at the household level in India.➤ Waste is accessible to waste pickers; they segregate it into saleable materials such as paper, plastics, glasses, metal pieces, textile, etc.➤ Pickers segregate the wastes directly from the dumps and bins with no precautions and they are exposed directly to harmful wastes.➤ The separated waste is sold to a small waste dealer, from where the waste is transferred to a medium sized dealer or wholesaler.➤ All these activities are not regulated or monitored by any governmental organisation. Due to this informal segregation, volume reduction is achieved, while it ignores social, economic, environmental, and health aspects. <p><i>(Note: Student may Wright any appropriate explanation so credit may be given accordingly.)</i></p>	