Important Instructions to examiners:

1) The answer should be examined by keywords 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.

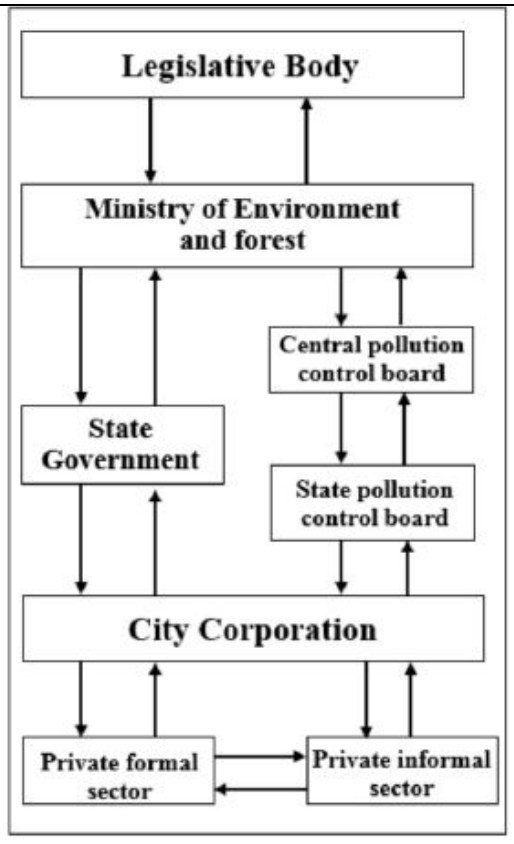
3) The language error such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skill).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure 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 the some cases, the assumed constants values may vary and there may be some difference in the candidates answer 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

Question and Model Answers	Marks
Q.1. Attempt ANY FIVE of the following	**20M**
a) Define 'Solid Waste', also list different types of Solid Waste.	**4M**
Definition.- Solid waste are all the wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted. **Types of solid waste-** i. Garbage ii. Ashes and residues iii. Combustible and non-combustible wastes iv. Bulky wastes v. Street wastes vi. Biodegradable and non-biodegradable wastes vii. Dead animals viii. Abandoned vehicles ix. Construction and demolition wastes x. Farm wastes xi. Hazardous wastes xii. Sewage wastes	**2M** **1/2 M Each (for any Four)**

b) Explain the impact of Solid Waste on environment.	**4M**
1. Ground water contamination by the leachate generated by the waste dump Surface water contamination by the run-off from the waste dump 2. Bad odour, pests, rodents and wind-blown litter in and around the waste dump Generation of inflammable gas (e.g. methane) within the waste dump 3. Bird menace above the waste dump which affects flight of aircraft 4. Fires within the waste dump. 5. Erosion and stability problems relating to slopes of the waste dump 6. Epidemics through stray animals. 7. Acidity to surrounding soil and Release of green house gas. 8. 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. 9. Change in climate and destruction of ozone layer due to waste biodegradable 10. 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. 11. Open air dumping creates unhygienic and poses enormous threat to the people. Causes aesthetic problem and nuisance due to nauseating pungent odor. 12. Promotes spreading of diseases. 13. The situation further aggravated by the indiscriminate disposal of Hospital and Clinical Waste. 14. Presence of extremely high level of total and Facial E-coli form.	**1M each (for any Four)**
C) Draw the organization pattern of Solid Waste Management.	**4M**
	**03 M For Neat labeled sketch** **1M for correct sequence**

d) State the four disadvantages of landfill method.	**4M**
Disadvantages of Landfill- 1. Possibility of contamination of water sources by waste water resulting from landfill. 2. Requires proper planning, design, and operation 3. The site will look ugly whilst it is being used for landfill 4. Dangerous gases are given off from landfill sites that cause local air pollution and contribute to global warming. 5. Once the site has been filled it might not be able to be used for redevelopment as it might be too polluted. 6. The trucks delivering the waste to the site are very big and noisy. They will spoil the peace and quiet in the area and could also contribute to traffic congestion (traffic jams) in the local area. 7. The gases given off from the site as the waste begins to decompose (break down) will cause the air in the local area to be smelly.	**1M each (for any Four)**
e) List various types of Special Waste.	**4M**
Types of Special Waste – **1. Radioactive substance-** (Biomedical research facilities, colleges and university laboratories, offices, hospitals, nuclear power plants, etc.) **2. Toxic Chemicals-** Agricultural chemical companies, battery shops, car washes, chemical shops, college and university laboratories, construction companies, electric utilities, hospitals and clinics, industrial cooling towers, newspaper and photographic solutions, nuclear power plants, pest control agencies, photographic processing facilities, plating shops, service stations, etc. **3. Biomedical wastes-** Biomedical research facilities, drug companies, hospitals, medical clinics, etc. **4. Flammable wastes-** Dry cleaners, petroleum reclamation plants, petroleum refining and processing facilities, service stations, tanker truck cleaning stations, etc. **5. Explosive waste-** Construction companies, dry cleaners, ammunition production facilities, etc. **6. E-Waste –** Residential, Electronic/Electrical repair shops **7. Industrial waste-** Cement, steel, sugar, food industry etc.	**1 M each (for any four)**
f) Explain the health safety measures to be adopted during handling and processing Solid Waste.	**4 M**
Health safety measures during handling and processing of solid waste: 1. Worker on field should wear hand gloves. 2. They should wear safety shoes. 3. To avoid polluted air they should wear mask. 4. Every month complete medical checkup should be done. 5. Provide safety goggles to avoid eye disease. 6. Separation of solid waste according to category. (dry, wet, medical, commercial, residential, etc)	**1 M for each (any Four)**

g) State the four benefits of recycling of Solid Waste.	4M
1. Reduces the amount of waste sent to landfills and incinerators. 2. Conserves natural resources such as timber, water and minerals. 3. Saves energy. 4. Prevents pollution by reducing the need to collect new raw materials. 5. Helps sustain the environment for future generations. 6. Reduce greenhouse gas emissions that contribute to global climate change.	**1M each (for any Four)**
Q.2 Attempt any FOUR of the following:	**16 M**
a) Explain the various sources of solid waste.	
(i) **Residential:** This refers to wastes from dwellings, apartments, etc., and consists of leftover food, vegetable peels, plastic, clothes, ashes, etc. (ii) **Commercial:** This refers to wastes consisting of leftover food, glasses, metals, ashes, etc., generated from stores, restaurants, markets, hotels, motels, auto-repair shops, medical facilities, etc. (iii) **Institutional:** This mainly consists of paper, plastic, glasses, etc., generated from educational, administrative and public buildings such as schools, colleges, offices, prisons, etc. (iv) **Municipal:** This includes dust, leafy matter, building debris, treatment plant residual sludge, etc., generated from various municipal activities like construction and demolition, street cleaning, landscaping, etc. (v) **Industrial:** This mainly consists of process wastes, ashes, demolition and construction wastes**,** hazardous wastes, etc., due to industrial activities. (vi) **Agricultural:** This mainly consists of spoiled food grains and vegetables, agricultural remains, litter, etc., generated from fields, orchards, vineyards, farms, etc. (vii) **Open areas**: this includes wastes from areas such as Streets, alleys, parks, vacant lots, playgrounds, beaches, highways, recreational areas, etc.	**1M Each (For any Four)**
b) State the four factors affecting on solid waste generation.	
➢ Living standard ➢ Awareness of people ➢ Source reduction/recycling ➢ Geographic location ➢ Collection Frequency ➢ Per person income ➢ Public attitudes ➢ Size of households ➢ Population density ➢ Population increase	**1M each (for any Four)**
c) List the various eight types of collection and transportation equipment of solid waste.	
1. Litter bin 2. Broom 3. Shovels 4. Container 5. Handcarts 6. Animal carts 7. Tractors and Trailers 8.Auto vehicle 9.Trucks. 10.Dumper 11.Compactors vehicles.	**½ M Each (For any Eight)**

d) State the various methods of storage of municipal solid waste.	
1) Large numbers of open communal storage sites and unofficial dumps. 2) Plastic buckets (with lids), with capacities between 7 and 10 L, 3) Plastic bins (with lids), with capacities between 30 and 60 L and equipped with handles 4) Galvanized steel or plastic bins (with lids), with a capacity between 50 and 70 L, 5) Disposable plastic bags have a number of advantages. 6) Other items commonly used for the storage of wastes include cardboard boxes, kerosene cans, and containers made out of truck tires. 7) DEPOTS a depot typically consists of a single-story building about the size of a large garage. 8) ENCLOSURES an enclosure is probably the most common communal storage method in Asia. Enclosures can have capacities from 1 to 10 m3 9) FIXED storage bins this type of container usually is built from concrete blocks.	**½ M Each (For any Eight)**
e) Explain any two methods of collection of municipal waste.	
(A) Collection system Based on the availability of service **1. Curb (Kerb-side)** Kerb side collection, or curbside collection, is a service provided to households, typically in urban and suburban areas, of removing household waste. House owner is responsible for placing solid waste containers at the curb on scheduled day. The work man come, collect and empty the container and put back at the curb. House owner is required to take back the empty containers from the curb to his house. **2. 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. **3. 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. **4. 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. **B) Collection Method Based on mode of operation:** **1. Hauled Container System** 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. **2. Stationary Container System** In this system, containers used for the storage of waste remain at the point of collection. The collection vehicles generally stop alongside the storage containers, and collection crews load the waste from the storage containers into the collection vehicles and then transport the waste to the processing, transfer or disposal site.	**02M each (for any TWO methods)**

f) Explain principle of composting Process and favourable condition for it.

Principle of composting

Decomposition and stabilization of organic waste matter is a natural phenomenon. Composting can be carried out in two ways i.e., aerobically and anaerobically.

During aerobic composting aerobic micro-organisms oxidise organic compounds to Carbon dioxide, Nitrite and Nitrate. During anaerobic process, the anaerobic micro-organisms, while metabolizing the nutrients, break down the organic compounds through a process of reduction. A very small amount of energy is released during the process. The end result of composting is an accumulation of partially decayed organic matter called humus.

02 M

Favourable condition for composting

- Certain **temperatures** promote rapid composting and destroy pathogens and weed seeds
- Microorganisms living in a compost pile need an **adequate amount of moisture** to survive.
- Providing **proper ventilation** by designing the composting toilet with a vent pipe.
- The proper balance of nutrients is vital to the composting process. A good **carbon/nitrogen (C/N) ratio** for a compost toilet is 20/1 to 35/1.

½ M Each

Q. 3. Attempt Any FOUR of the following — **16M**

a) Differentiate between Bangalore and Indore methods of composting. — **4M**

Bangalore method of composting	Indore method of composting
Bangalore method is commonly used anaerobic method used for biological conversion of organic component of municipal solid waste.	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.
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 providing at top.	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.
The soil cover not only prevent odour but also prevents breeding of files.	Refuse should be turn once or twice per week which introduce oxygen and helps to control temperature.
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.	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.
During biological action head is evolved which rises temperature of decomposing mass.	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.

4M

1 M each for any four points.

Alternate Solution for Q-3 (a)
OR

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

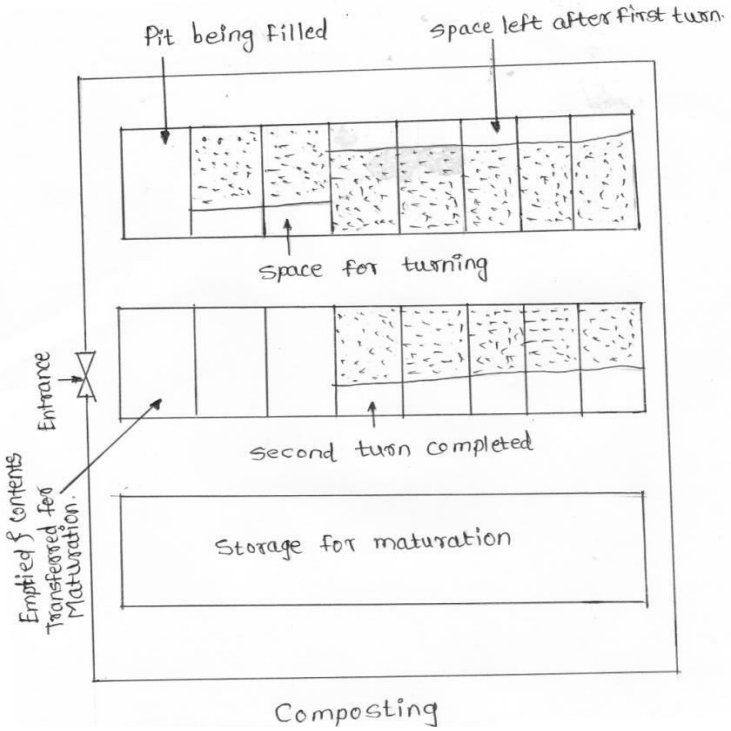
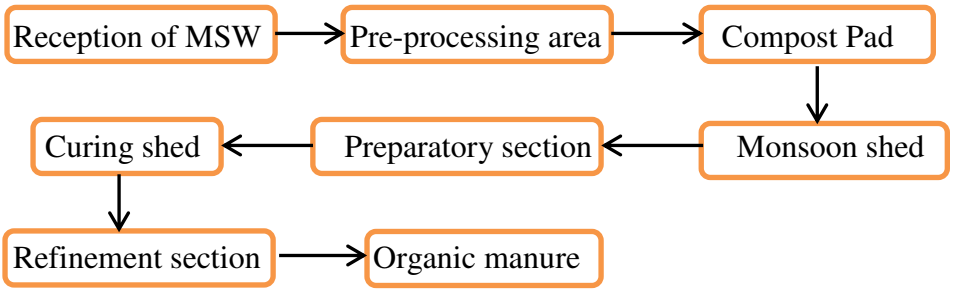
b) Explain advantages of vermicomposting method also mention its suitability. — **4M**

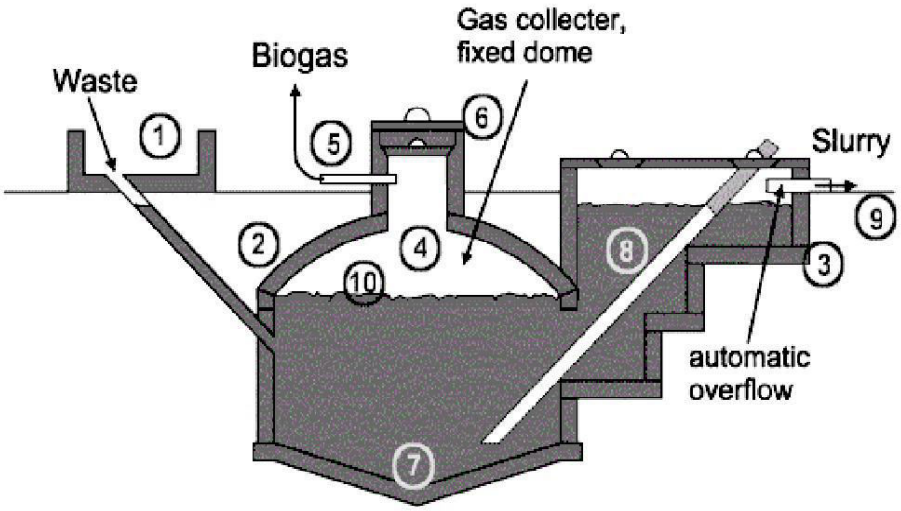
- **Advantages of Vermicomposting-** — **1/2M each (for any four)**
  1. Increase moisture and nutrient retention of the soil.
  2. It provides efficient conversion of organic wastes.
  3. Improves aeration and root penetration.
  4. Reduces crusting of soil surface.
  5. Micro-nutrients are added.
  6. Increases the number of beneficial soil microorganisms
- **Suitability of Vermicomposting –** — **1M each (any two)**
  1. Vermicomposting plays a vital role in waste management. Hence it is used in back of the house areas and kitchen.
  2. It is eco-friendly technique, hence it can be adopted for organic waste from industries (viz. sugar, food industry etc.).
  3. The nutrients from manure can be used for farms and gardens.
  4. It improves the quality of fruits and vegetables.

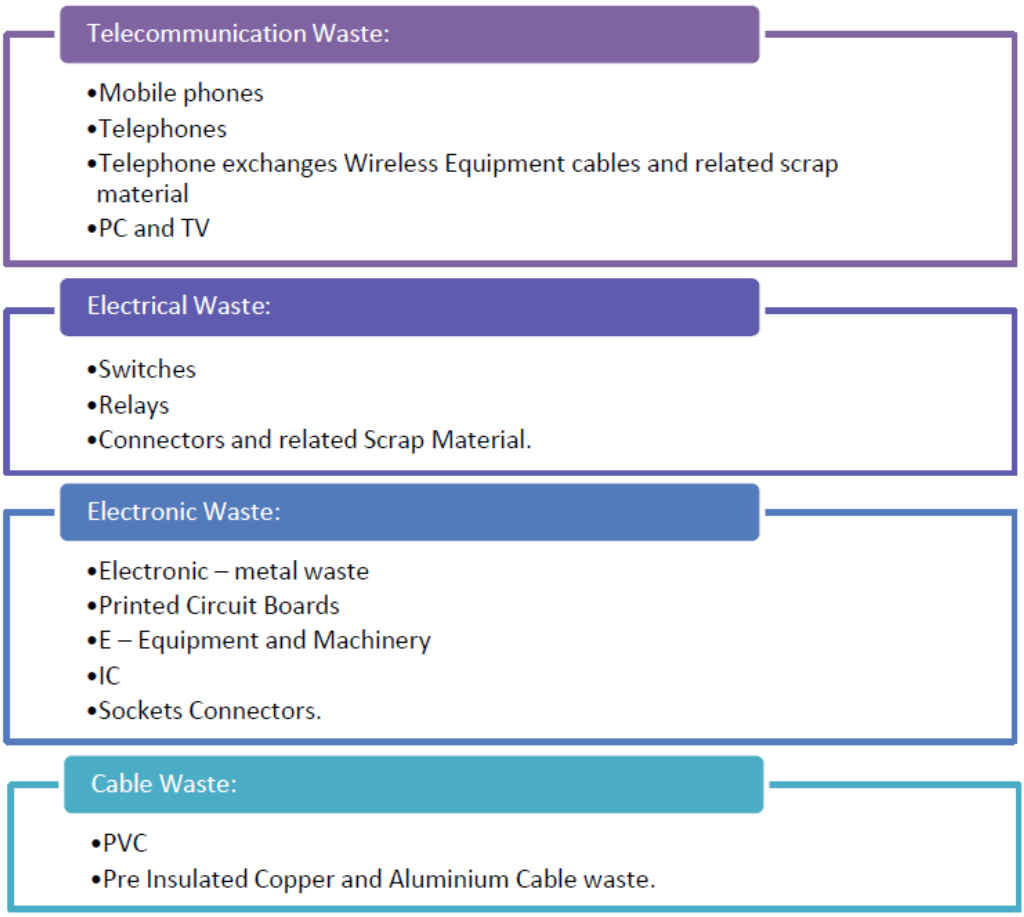
c) State the four factors affecting the site selection for land filling technique to dispose solid waste. — **4M**

1. No Residential area should be located near the boundaries of landfill site.
2. The site should be provided all facilities such as drinking water, Electricity, Roads for transportation.
3. It should be free from Seismic Zone.
4. Selection of landfill site should be based upon the examination of environmental issues.
5. Land area and volume should be sufficient enough to provide landfill capacity.
6. The landfill area having steep gradient (where stability of slope could be problematic) should not be selected.

1M each for any Four

7. The water level in ground water table should be sufficient below the base of any excavation to enable landfill development. 8. There should not be fault lines and significantly fractured geological structure. 9. Landfill site should be away from airports.	
d) Explain the mechanical Composting Method.	**4M**
➢ 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 2m3/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 • Reception of refuse • Segregation • Shredding • Stabilization • Marketing	**02 M For Explanation**
 **Mechanical Composting** **OR** ***Students may draw the flowchart of Dano Process which is called as Mechanical composting-***  **(Note- 2M may be given if students draw the flowchart of Dano process.)**	**02 M For Diagram**

e) Explain the working of biogas plant with the help of neat sketch.	4M
 1. Mixing tank with inlet pipe and sand trap. 2. Digester. 3. outlet chamber. 4. Gasholder. 5. Gas pipe. 6. Entry hatch, with gastight seal. 7. Accumulation of thick sludge. 8. Outlet pipe. 9. Reference level. 10. Supernatant scum, broken up by varying level. ➢ **Working of Biogas Plant -** 1. The various forms of biomass are mixed with an equal quantity of water in the mixing tank. This forms the slurry. 2. The slurry is fed into the digester through the inlet chamber. 3. When the digester is partially filled with the slurry, the introduction of slurry is stopped and the plant is left unused for about two months. 4. During these two months, anaerobic bacteria present in the slurry decompose or ferments the biomass in the presence of water. 5. As a result of anaerobic fermentation, biogas is formed, which starts collecting in the dome of the digester. 6. As more and more biogas starts collecting, the pressure exerted by the biogas forces the spent slurry into the outlet chamber. 7. From the outlet chamber, the spent slurry overflows into the overflow tank. 8. The spent slurry is manually removed from the overflow tank and used as manure for plants. 9. The gas valve connected to a system of pipelines is opened when a supply of biogas is required. 10. To obtain a continuous supply of biogas, a functioning plant can be fed continuously with the prepared slurry ***(Note- If the students draw the flowchart/all steps of biogas plant working then credit upto 2M may be given)***	**2M for neat labeled diagram** **2M**
f) Define – **i) Biomedical Waste ii) E-Waste**	**4M**
i) Biomedical Waste- Any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological, and including categories mentioned in schedule I.	**2M**

ii) E- Waste E-waste is any refuse created by discarded electronic and electrical devices and components as well as substances involved in their manufacture and repair process.	**2M**
Q.4 Attempt Any FOUR of the following	**16 M**
a) State the varieties of E-waste and why it is dangerous?	**4M**
➢ **Varieties of E-Waste-**  ➢ **Following are dangerous effect of hazardous substances that come out of E-waste:** 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.	**2M** **2M** **½ M Each (for any Four)**

b) Explain the methods of disposal and recycling of E-waste. — **4M**

Disposal of E-waste is done by following method:

2M for any one method

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. Advantages 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.

Recycling of E-waste is done by following method:

2 M

1) 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.

2) 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.

c) State types and characteristics of Solid Waste from engineering and chemical type of industries. — **4M**

Types of Solid waste from Engineering and Chemical type Industries-

2M

❖ Pulp and Paper Industry-

Sr. No.	Types of Solid Waste	Characteristics of Solid Waste
1	Grit	Oil and Grease
2	Fly ash	Fine dust
3	Sludge	High solids
4	Bleached pulp	High pH

❖ Chemical Industry-

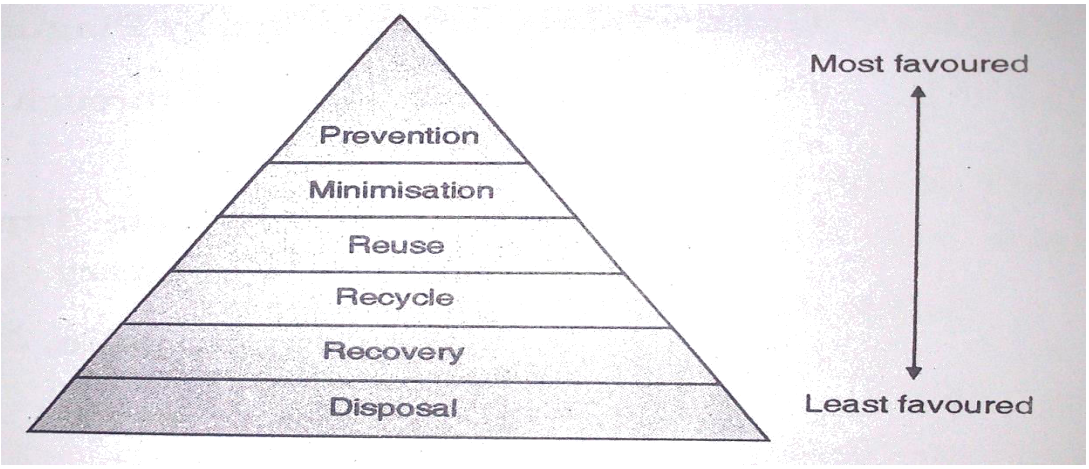
2M

Sr. No.	Types of Solid Waste	Characteristics of Solid Waste
1	Slag	Acidic or Alkaline
2	Mud	High suspended Solid
3	Residues of refining	High alkalinity
4	Scraps	Metal parts

(Note: Student may write any appropriate industrial solid waste so credit may be given accordingly)

d) Explain various control measures of industrial waste.	**4M**
1. **Optimization of resources**: waste reduction at individual and institutional level goes side by side with the utilization of raw materials. 2. **Using again the Scrap Material**: this is the process in which individual and 3. Industry reuses the waste material as soon as it is produced. This keeps it from becoming a waste material. 4. **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. 5. **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. 6. **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. 7. **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.	**01 M each (any four)**
e) Explain four salient features mentioned in biomedical waste management and handling as per 1998.	**4M**
The ministry of environment and forests notified the bio medical waste rules in July1998. Following are the features- 1. 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. 2. The hospitals, nursing homes, clinics, dispensaries, pathological laboratories etc. are therefore required to set in places the biomedical waste disposal & treatment facilities as per schedule V & VI respectively. 3. Segregation, packaging, transportation and storage of BMW according to schedule1, Schedule 2 &3, Schedule 4 respectively. 4. For the effective BMW management the state government shall establish prescribed authority for granting authorization to concern occupier/operator; who are required to maintain the annual & accident records of the facility. ***(Note- The students may explain any of the provision or schedule of the BMW rule-1998 then accordingly the credit may be given.)***	**01M for each point.**
f) What are the different types of health problems during time of segregation, reuse, recovery and recycling of Solid Waste possible to human being?	**4M**
Health problems during time of segregation, reuse, recovery and recycling of Solid Waste- The scavengers or rag-pickers work under extensive health risks, which are largely undocumented, and suffer severe exploitation and deprivation. The possible health hazards to human being include- 1. **Communicable diseases**- Houseflies may be important in the transmission of enteric infections, particularly responsible for infant diarrhea and dysentery. 2. **Non-Communicable diseases**- Solid waste during its segregation, reuse/recovery/recycling may cause eye irritation, respiratory diseases, hand/leg injuries, poisoning, hearing defects etc. 3. **Aesthetics**- Solid waste causes odour, visibility and dust problem to human being.	**01 M** **01 M** **01 M** **01 M**

Q.5 Attempt any TWO of the following:	16 M
a) Explain the Hierarchy of solid waste management.	**8M**



2M for Dia

Following are the various stages in SWM Hierarchy:

1. **Prevention**: preventing the use of such raw material in production which produces maximum solid waste and selecting the alternative raw materials.

2. **Minimization**: if such alternative raw materials are less possible then minimize the use of raw materials producing more waste by implementing different techniques.

3. **Reuse**: it is the next desirable option in which materials some materials are repeatedly used again and again for same purpose.

The following measures are therefore proposed to be taken to Reduce, Re-use and Recycling of waste by all concerned:

1M for Each Method

- All manufacturers producing a variety of domestic and non-domestic products, food as well as non-food should be persuaded to seriously endeavour to use re-usable packaging materials so that after the delivery of goods, the packaging materials could be collected back and used over and over again.
- Incentives and product discount should be given to consumers for the return of packaging or bottling materials in good condition, to the waste producers or retailers to promote re-use.
- 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.

4. **Recycle**: In this stage collection, sorting of recyclable products is done and then they are manufactured into new products.

5. **Recovery**: in this stage the recoverable materials are processed which includes activities like recycling and composting.

6. **Disposal**: It is the last option and should be considered after all other possible actions to recover that waste matter. It may includes incineration, dumping.

b) What is meaning of transfer station? And explain its Necessity and suitable Location.	**8M**
Defination.- 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 prior to loading into large vehicles. **Necessity of transfer stations:** Transfer stations are necessary due to following reasons 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. **Location** 1. It should be near to disposal site. 2. It should be in the area where traffic flow is smooth. 3. It should be in area where land and property rates are cheap. 4. It should not be in thickly populated and residential area.	**2M** **1M For each (any three)** **1M for each (any three)**
c) Describe the process of incineration and product of it with their use.	
Process of Incineration ➢ Incineration is a chemical reaction in which carbon, hydrogen and other elements in the waste, mix with oxygen in the combustion zone and generates heat. ➢ The air requirements for combustion of solid wastes are considerable. Usually, excess air is supplied to the incinerator to ensure complete mixing and combustion and to regulate operating temperature and control emissions. ➢ Excess air requirements, however, differ with moisture content of waste, heating values and the type of combustion technology employed. ➢ Many incinerators are designed to operate in the combustion zone of 900°C – 1100°C. This temperature is selected to ensure good combustion, complete elimination of odours and protection of the walls of the incinerator. ➢ Incinerator systems are designed to maximise waste burn out and heat output, while minimising emissions by balancing the oxygen (air) and the three "Ts", i.e., time, temperature and turbulence. ➢ Complete incineration of solid wastes produces virtually an inert residue, which constitutes about 10% of the initial weight and perhaps a larger reduction in volume. ➢ The residue is generally landfilled. The incineration facility along with combustion of waste emits air pollutants (i.e., fine particulate and toxic gases), which are an environmental concern, and, therefore, their control is necessary. **Product with their use** 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 or blending in cement. ***(Note- The students may write any appropriate incineration process, the credit of maximum 4M may be given accordingly)***	**4 M for process** **1M for each**

Q.6 Attempt any TWO of the following:	16M
a) Describe methods of collection and disposal of biomedical waste.	**8M**

Collection of biomedical waste are to be done by color coded bag as per schedule II as below. It is also collected separately according to category of medical waste.

02 M

Colour Coding	Type of Container -I	Waste Category	Treatment options as per Schedule I
Yellow	Plastic bag	Cat. 1, Cat. 2, and Cat. 3, Cat. 6.	Incineration/deep burial
Red	Disinfected container/plastic bag	Cat. 3, Cat. 6, Cat.7.	Autoclaving/Microwaving/ Chemical Treatment
Blue/White translucent	Plastic bag/puncture proof Container	Cat. 4, Cat. 7.	Autoclaving/Microwaving/ Chemical Treatment and destruction/shredding
Black	Plastic bag	Cat. 5 and Cat. 9 and Cat. 10. (solid)	Disposal in secured landfill

(Note- Treatment option in table is optional)

Disposal of Biomedical waste-

02M for each (any three)

1. Autoclaving

Thermal treatment is typically used for sharps and certain other types of infectious waste. An autoclave is like a large pressure cooker that uses high temperatures and steam to deeply penetrate all materials and kill any microorganisms. Depending on the type and amount of waste you will need to sterilize.

Modern autoclaves are also automated to minimize human involvement and therefore reduce needle-stick injuries and contamination.

2. Chemical Treatment

Often used to deactivate liquid waste, chemical treatment is designed to decontaminate or deactivate certain wastes on site rather than packaging and sending them to a separate facility.

Chemical treatment can also be applied to some non-liquid infectious wastes, but they would typically need to be shredded first to ensure that all portions of the waste are exposed to the chemicals.

Depending on the type of waste, chemicals like chlorine, sodium hydroxide or calcium oxide can be used. Chemical treatment has to be executed carefully and by knowledgeable staff.

3. Microwave Treatment

A microwave treatment system, similar to an autoclave, also uses heat to decontaminate medical waste. These systems work best for waste that is not 100% dry or solid, as the moisture allows the heat to penetrate deeper, and the steam sterilizes.

4. Incineration Incineration is typically used for pathological and pharmaceutical waste. Incineration of medical waste should be performed in a controlled facility to ensure complete combustion and minimize any negative effects for the environment. **5. Land Disposal** Land disposal is typically used for shredded, treated and decontaminated waste. In certain cases, it can also be used for hazardous waste or other untreated waste that can not be decontaminated by other means. Specialized sanitary landfill sites exit to reduce the risk of soil and water contamination and provide a safe space for medical waste disposal. **6. Deep Burial** A pit or trench is excavated about 2m deep. It is half filled with waste, and then covered with lime within 50 cm of the surface, then filling the remaining portion with soil. Cover is provided at top with lock facility	
b) Explain the importance of public involvement and participation in solid waste management.	
Public involvement and participation in SWM is very important because of following points: 1. To increase the awareness of solid waste management among the people. 2. To increase the efficiency and effectiveness of planning process and Implementation of solid waste management. 3. To understand the planning importance and significance. 4. To play an important role in the permitting process in case of hazardous waste as well as municipal waste facilities. 5. To improve the waste management strategies, negotiations with municipal authorities for better involvement in decision making. 6. To achieve the '3R'principles. 7. To reduce littering of waste on streets and into drains, open spaces, etc. 8. To encourage and assists the local composting and recycling initiatives.	**1M for each**
c) State the benefits of recycling and marketing strategies for recyclable.	
Benefits ➢ 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. **Marketing strategies for recyclable** There are a number of techniques for recycling business could use to reach potential new customers. These include:	**4M (1M for each) benefit)**

1. Mailshots by post or email. If you use bought business mailing lists, it is important to ensure that these are as up to date as possible with valid contact details for key decision-makers. **2. Advertising** in the press, radio, billboards and even television. While useful in terms of raising awareness services. **3. Public relations** and press releases. As with advertising, this may help increase awareness, but may not lead to many new enquiries. Collection **vehicle branding** to promote services. This is relatively cheap and is important in presenting a professional image to current and potential customers. **4. Online marketing** via a dedicated website or search engines ads. A well-designed website can be a relatively low-cost way of attracting new customers.	**04 M (1M for each strategy)**