MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
.
(ISO/IEC -270001 – 2005 certified)

WINTER -2019 EXAMINATION **SUBJECT CODE: 17605**

MODEL ANSWER

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.

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 some cases, the assumed constants values may vary and there may be some difference in the candidate's 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.

Que. NO	Answer with question	Marks
Q. 1	**Attempt any FIVE of the following**	**20 M**
a)	**Define a) Solid Waste b) Hazardous waste**	
Ans.	**Solid Waste**: It is defined as non soluble material that is thrown away in a solid or semi solid form. This includes garbage, refuse, sludge and other domestic materials as well as waste from industries, commercial, agricultural and mining operations. **Or** All the wastes arising from human and animal activities that are normanlly solid and that are discarded as useless/unwanted. **b) Hazardous Waste:** It is defined as the waste that can have substantial or potential threats to public health or the environment. This waste includes ignitable, reactive, corrosive and toxic waste.	**2 M** **2 M**

b)	**Explain the health problems associated with handling and processing of solid waste.**	
Ans.	**Health problems associated with handling and Processing of solid waste:** • **Infections**- Skin and blood infection due to direct contact with solid waste. - Eye and respiratory infections due to infected dust. - Various diseases due to bites of animals feeding on waste. - Intestinal infection transmitted by flies feeding on the waste. • **Chronic diseases**- The incinerator operators are at the risk of chronic respiratory diseases including cancer due to exposure of incinerated products and hazardous compounds • **Accidents** – During handling of heavy containers, it causes bone or muscle disorders. - Cutting caused due to sharp objects present in the waste - Burning caused due to hazardous chemicals mixed in the waste	**2 M** **1 M** **1 M**
c)	**Explain any four characteristics of Hazardous waste.**	
Ans.	• **Ignitability** – Ignitable wastes creates fires under certain conditions or wastes which are spontaneously combustible, or have a flash point less than 60^{o}C. • **Corrosivity** – Corrosive waste are acids or bases that are capable of corroding metal containers, such as storage tanks, drums and barrels. • **Reactivity**- Reactive wastes are unstable under normal conditions. They can cause explosions, toxic fumes, gases, or vapours when mixed with water. • **Toxicity**- Toxic wastes are harmful or fatal when ingested or absorbed. When toxic wastes are disposed of on land, the liquid drained from this waste get contaminated which forms leachate.	**1 M each**
d)	**Explain equipments used for collection and transportation of solid waste.**	
Ans.	**Equipments used for collection and transportation of solid waste** • **Litter bin:** It is provided on road side having capacity 60 to 150 Lit. It is useful for collecting the waste to be thrown by citizens moving on the road. • **Broom:** The long handle brooms are useful for sweeping the streets. • **Shovels:** It is useful for digging, lifting and moving the bulk waste materials. The broad blade fixed shovels are most commonly used for collection of waste. • **Hand Carts:** It is the fabricated hand moving vehicle which contains 6 to 8 bins having 25 lit capacity. It is suitable for collecting the waste from very narrow roads location.	**2 M (For collection equip)**

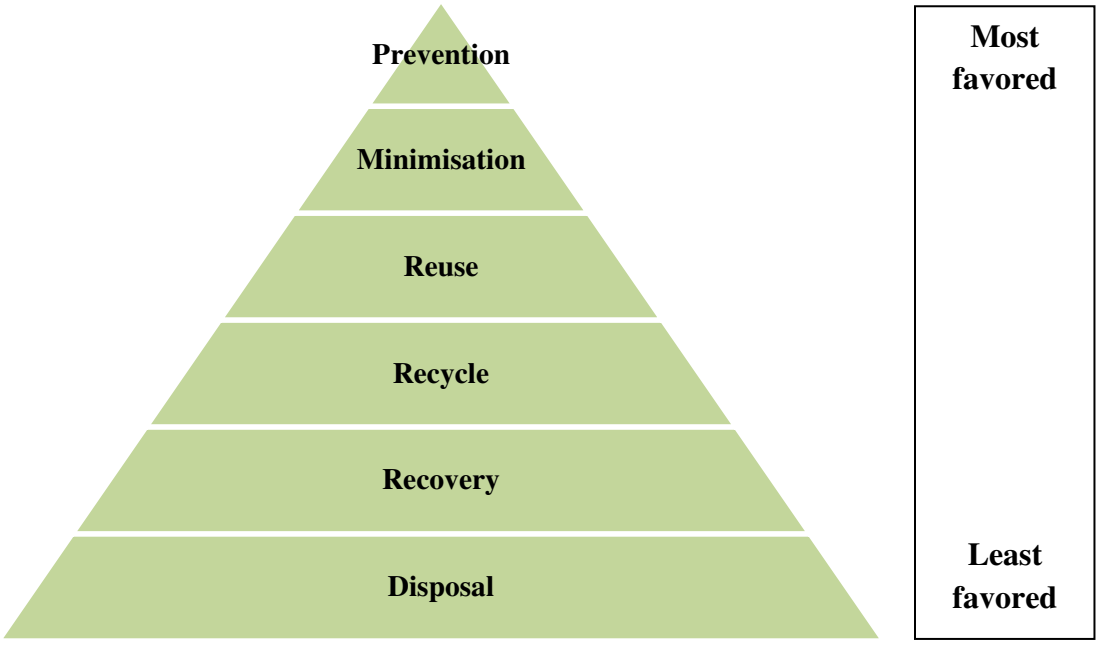
	• **Animal Carts:** These vehicles are driven by horses, donkeys and other animals used for collecting the waste. The capacity of these vehicles varies from 2 to 4 m^3. There is no need of fuel for collection of waste. • **Mechanical Road Sweeper:** The Street sweepers are mounted on the collecting trucks provided with suction mechanism which clean the street with and the waste is sucked by vacuum action in the truck. • **Tractors:** The tractors having capacity 6 m^3 are useful for collecting the refuse from household or storage points. • **Trucks:** Trucks having capacity 5 to 6 m^3 are useful for collection and transportation of waste from communal sites. • **Dumpers:** Dumpers are used for collection and transportation of large quantity of solid waste. The main advantage of using dumper is that it can be empted immediately due to hydraulic mechanism. This type of vehicle utilises body capacities of about 12 m^3 • **Compactor vehicles:** A compactor vehicles compact the solid waste by using mechanical pressure which reduce the volume of waste. The capacity of this vehicle varies from 5 to 10 m^3 ***(Note: Incase of figures drawn by students, provide appropriate marks)***	**2M (For transportation equip.)**
e)	**Describe Pyrolysis process of waste treatment and its advantages.**	
Ans.	**Pyrolysis Process of waste Treatment:** It is the process of thermal decomposition of organic matter at high temperature in an inert (oxygen deficient) atmosphere or vacuum, producing a mixture of combustible (Carbon monoxide, Methane, Hydrogen, Ethane [CO, CH_4, H_2, C_2H_6]) and non combustible gases. **Advantages of Pyrolysis Process:** 1. Reduces greenhouse gases emissions and waste going to landfill. 2. Produces a marketable product like gases, bio-oil, bio-chemicals and charcoal. 3. Low risk of water pollution. 4. Low risk of odour. 5. High recovery rate of resources. 6. Minimal risk of health consequences.	**2 M** **2 M (Any 4)**
f)	**Define 'E-waste' and enlist its sources.**	
Ans.	**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.	**2 M**

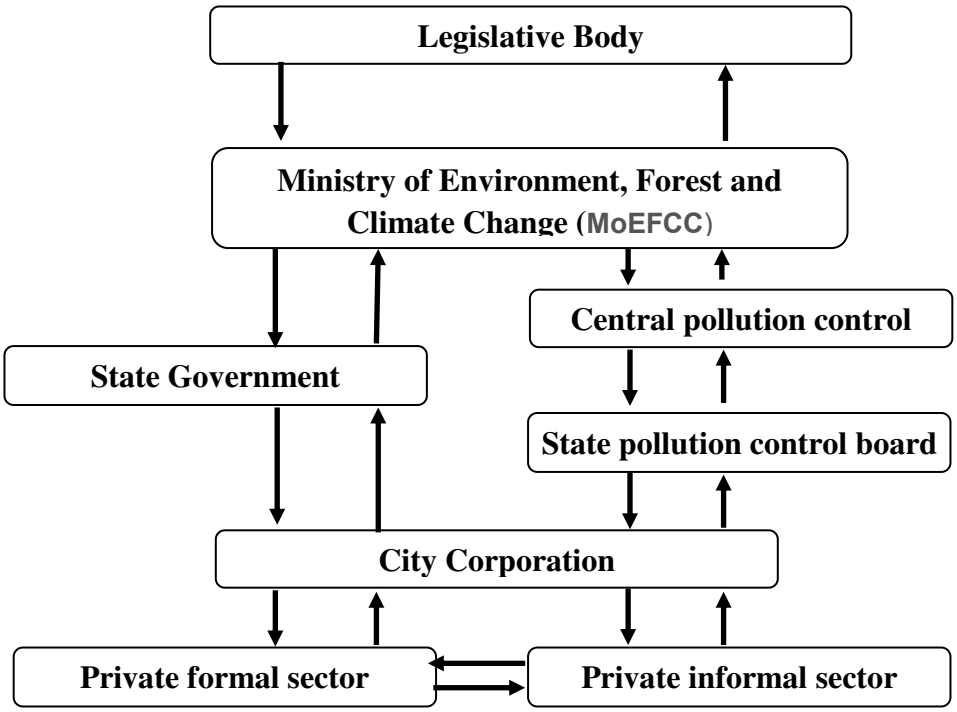
	Sources of E-waste: 1. **Large Household Appliances** (Washing machine, Refrigerators, A.C. etc.) 2. **Small Household Appliances** (Vacuum cleaner, Coffee machine, Iron etc.) 3. **Office, Information and Communication Equipment** (PC's, Laptops, Mobiles, Telephones, Fax machines, Printers etc.) 4. **Entertainment and Consumer, Electronics and Toys, Leisure, Sports and Recreational Equipment's.** (Televisions, VCR/DVD Players, Hi-Fi sets, Radio etc and electric train, Treadmills, Vending machine etc.) 5. **Lighting Equipment** (Fluorescent tubes and lamps, electric fused bulbs and tube lights etc.) 6. **Electric and Electronic Tools** (Drills, Electric saws, Sewing machines etc.) 7. **Security and Health Care Equipment** (Surveillance and control equipment and medical instruments etc.)	**2 M (Any 4)**
g)	**Describe control measures of industrial waste**	
Ans.	**Control measures of industrial waste:** 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 industry reuses the waste material as soon as it is produced. This keeps it from becoming a waste material. 3. **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. 4. **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. 5. **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 less packages and wrappings can save from the waste production. 6. **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.	**4 M (Any 4 points)**
Q. 2	**Attempt any FOUR of the following:**	**16 M**
a)	**State the factors affecting generation of solid waste.**	
Ans.	**Factors affecting generation of solid waste:** 1. Population 2. Urbanization 3. Industrialization	**½ M each**

	4. Life style of citizens 5. Family income 6. Size of family 7. Climatic condition of the area 8. Tourist number. 9. Habits and culture of the people 10. Source reduction / recycling	**½ M each (Any 8)**
b)	**Enlist the collection methods of municipal solid waste and explain any one.**	
Ans.	**Methods of collection of municipal solid waste:** **i) Collection system Based on the availability of service:** • Curb (Kerb-side) • Alley Service • Set out Set Back Service • Backyard Service **ii) Collection Method Based on mode of operation:** • Hauled Container System • Stationary Container System **i) 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 empties 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 backyard and empty the solid waste container in it. The wheel barrow or bin is then taken to solid waste vehicle where it is emptied.	**1 M** **1 M** **2 M (Any one)**

	ii) 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.	
c)	**Define composting and describe principle of composting process.**	
Ans.	**Composting:** Composting is the biological decomposition of organic waste such as food or plant material by bacteria, fungi, worms and other organism under controlled conditions. The end result of composting is an accumulation of partially decayed organic matter is called humus. **Principle of composting process:** Composting can be carried out in two ways: Aerobically and Anaerobically. During **aerobic composting** process, aerobic micro organisms oxidise organic compounds to carbon dioxide, nitrite and nitrate. Carbon from organic compound is used as sources of energy while nitrogen is recycled. Due to exothermic reaction temperature of the mass rises. During **anaerobic composting** process, the anaerobic micro organisms, while metabolising the nutrients, break done the organic compounds through a process of reduction. A very small amount of energy is released during the process and the temperature of composting mass does not raise much. The gases evolved are mainly methane and carbon dioxide.	**2 M** **1 M** **1 M**
d)	**State the benefits of recycling of Industrial waste.**	
Ans.	**Benefits of recycling of Industrial waste:** 1. Fly ash waste from thermal plants is recycled for manufacturing of cement, light weight aggregates, insulating bricks, precast concrete, soil stabilization, land reclamation etc. 2. Blast furnace slag from steel plants is recycled for manufacture of cement, refractory, ceramic material, aggregates etc. 3. Phosphogypsum waste from Chemical plants is recycled for manufacture of gypsum	**1 M each (Any four)**

	plaster, boards, tiles, cement products etc. 4. Nonferrous metal industry waste is recycled for manufacture of binder material, construction blocks, heavy clay products, colored concrete, floor tiles, polymer doors etc. 5. Lime sludge from paper allied industries is recycled for manufacturing of building lime, masonry cement, lime bricks, binder materials etc.	
e)	**State the steps in recycling of solid waste and explain any one.**	
Ans.	**Steps in recycling of solid waste:** • Collection and processing • Sorting • Manufacturing • Purchasing new products made from recycled materials **Collection and processing:** The methods used for collection of recyclable solid waste are as follows: - Curbeside collection - Drop off centers - Buyback centers - Single stream collection - Deposit or refund programs **Sorting:** After collection the recyclable solid waste is sorted out in different categories as biodegradable and non-biodegradable materials. The sorted waste is further sent to manufacturing industries for reusing waste as a raw material. **Manufacturing:** The recyclable products like news papers, aluminium, plastic, glass, steel cans etc. are cleaned and used as a raw material for manufacturing of new products. **Purchasing new products made from recycled materials:** The products which are manufactured using recyclable material are promoted in market by advertising and making awareness among the peoples to purchase these products.	**2 M** **2 M (Any One)**
f)	**Explain the health problems during reuse, recovery and recycling of solid waste.**	
Ans.	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 diarrhoea 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.	**1.5 M** **1.5 M** **1M**

Q.3	Attempt any FOUR of the following:	16 M
(a)	**Explain solid waste management hierarchy.**	
	Following are the solid waste management 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 some materials are repeatedly used again and again for same purpose. 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.	**1M** **½ M each**

(b)	**Draw organization pattern of solid waste management.**	
	 **Organization pattern of solid waste management**	**03 M For Neat labeled sketch** **1M for correct sequence**
(c)	**Enlist factors affecting composting and explain any two of them.**	
	Following are the factors affecting composting 1) Temperature 2) Moisture content 3) C/N ratio 4) Micro-Organism 5) Aeration 6) Use of cultures 7) Addition of sewage and sewage sludge 8) Particle size 9) pH **Explaination –** 1. **Temperature -** The temperature is directly proportional to rate of biodegradation. Optimum temperature is 30°C – 50°C beyond which nitrogen loss occur. In aerobic composting temperature may go upto 70°C 2. **Moisture Content –** More moisture content beyond optimum value may create anaerobic condition. The optimum moisture content is 50-60%. 3. **C/N ratio-** It is the carbon to nitrogen ratio. The optimum value should be 25-30. If carbon is less means C/N ratio less than 25 add straw,sawdust, and if Nitrogen is less	**½ M each for any four** **01 M each for explain**

	means C/N ratio more than 25 add sludge, slaughter house waste to improve ratio. 4. **Micro-organism –** Microorganisms is prime responsible for biodegradation process. Sufficient quantity of microorganism should be available. In first stage of biodegradation Mesophillic bacteria(15-40^{o}C) acts and in second stage Thermophilic bacteria (45-60^{o}C) acts. 5. **Aeration -** During the decomposition process oxygen in mass get deplete, hence it needs to add oxygen externally. This is done by well mixing of total mass every 5 days. The artificial air supply is at the rate of 1-2 m^3/day.kg 6. **Use of cultures –** Extraneous organism in the form of inoculums is added for maintaining sufficient quantity of microorganisms required for biodegradation.	**any two**
(d)	**Explain disposal methods of Industrial waste.**	
	Following are the methods of disposal of Industrial waste: 1) **Manual separation or salvage:** It is a process to recover and reuse of industrial waste separated manually before disposal. 2) **Mechanical volume reduction:** After separation industrial waste compressed using compactors to reduce volume. 3) **Thermal volume reduction or Incineration:** Combustion of combustible waste and residue as a ash. 4) **Open dumping:** It is simplest and economical method of disposal. In this industrial waste are dumped in low laying areas. 5) **Controlled tipping:** The industrial waste spread in layers and each layer is properly covered by a layer of soil 6) **Destructive distillation:** In this method industrial waste are heated under anaerobic condition. 7) **Land farming:** The biodegradable industrial wastes are treated by biological, physical and chemical process on the land. 8) **Biodegradation:** In this method composting process is applied on organic industrial waste.	**01 M each any four**
(e)	**Describe incineration and explain any one of its type**	
	Incineration: It is controlled combustion process of waste at high temperature and converts into residue and gaseous products. 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. However an excess air requirement depends on moisture content of waste, heating values and the type of combustion technology applied. 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. 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.	**03 M**

	Types of incineration- 1) **Mass burn Incinerator:** In this incinerator continuous added of waste using grate system. These incinerators are convenient and flexible. 2) **Modular Incinerators:** It consists of two combustion chambers and better control on pollution. These incinerators are prefabricated and relatively small size. 3) **RDF based Incineration:** It is homogeneous and better control on combustion process. This method of disposal recovers more energy. 4) **Fluidized bed incineration:** This type of incinerator is most suitable for sewage sludge and chemical waste combustion.	**01 M any one type**
(f)	**Explain disposal methods of 'E-waste'**	
	The disposal Methods of E waste are: **1) Recycling –** Recycling involves dismantling and recovery of valuable material. Monitors, CRT, keyboards, laptop, telephone board, CD, mobiles, CPU, cables can be recycled. **2) Reuse** – By adopting second hand use with little modification we can reuse equipment/material and thereby reducing quantity of solid waste. E.g. Donating old version computers to primary school etc. **3) Land filling:** Trenches are made on flat surfaces or undulations on ground surface also utilized. Soil is excavated from the trenches and waste material is buried in it, which is covered by thick layer of soil. Presently secure land filling are provided with some facilities like impervious liner made up of plastic or impervious clay. Leachate collection basin is provided to collect and transfer the leachate to leachate 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. **4) 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 is the reduction of waste volume and utilization of energy content of combustible materials. However polluted gasses and large amount of combustions are produces.	**1M each**
Q. 4	**Attempt any FOUR of the following:**	**4× 4=16**
(a)	**Describe any one Indore or Bangalore method from manual composting process.** **Indore method:** This method is aerobic activity; still in between turning it becomes anaerobic. it consist of layers of vegetable and night soil is alternative piled into trench, the depth of pile is 1.5 to 2 m and widths is about 3 to 8 m or above the ground form a mound called windrow. Normally windrows are conical in shape and about 50 m 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 to 5 weeks during which biodegradable organic are consumed. The solid waste in windrow may take 21 to 28 days for	**4 M for any one method**

	stabilization. The composted waste is removed from windrow and allowed to mature in maturing yards for 1 to 3 months, after which the compost becomes ready for being taken out for use. **Bangalore method:** Bangalore method is anaerobic activity 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 and breeding of files. Final layer of soil is providing at top. Within 2 to 3 days of burial intensive biological action starts taking place and organic matter beings to be destroyed. After 4 to 5 months complete stabilization of waste takes placed. It is slow method.	
(b)	**Describe situation of solid waste recycling in India.**	
	A municipal solid waste rule promotes application of the 3R's. However, In India there is no formal recycling system available. On the other hand repair, reprocess & reuse of waste materials is a common practice in unorganized manner. Informal recyclers play important role in this process by unrecognized and unorganized way. In India presently recycling of dry recyclables is taking place at household levels which is more economical than sorting at a centralized facility. These sorting such as paper, iron, rubber, plastic, glass, furniture, cloths etc. collected by Bhangarwala agents from individuals paying some money. Similarly Rag pickers on street, dumping grounds segregate saleable materials such as paper, plastic, glass, metal, textile etc. These activities are not monitored by government organizations hence it ignores social, economic, environment and health aspects.	**4 M**
(c)	**Describe the collection of biomedical waste by type of waste and colour code used for collection of bags.**	
	Collection of biomedical waste are to be done by color coded bag as per schedule II of biomedical waste (Management and Handling) rules 1998 as below. It is also collected separately according to category of medical waste.	**01 M (each Colour coding)**

Waste Category	**Colour Coding**	**Type of Container**
Cat.1: Human Anatomical Waste (tissues, organs, body parts), Cat. 2: Animal Waste (tissues, organs, body parts) Cat.3: Microbiology & Biotechnology Waste (lab cultures, cell cultures) Cat. 6: Solid Waste (Dressings, soiled cotton, plaster, beddings, lines).	Yellow	Plastic bag
Cat.3: Microbiology & Biotechnology Waste (lab cultures, cell cultures) Cat. 6: Solid Waste (Dressings, soiled cotton, plaster, beddings, lines) Cat. 7: Solid Waste (tubing, catheters,	Red	Disinfected container/plastic bag

		intravenous sets)		
		Cat. 4: Waste Sharps (needles, syringes, scalpels, blades, glass) Cat. 7: Solid Waste (tubing, catheters, intravenous sets)	Blue/ White translucent	Plastic bag/puncture proof Container
		Cat. 5: Discarded Medicines & Cytotoxic Wastes Cat. 9: Incineration Ash Cat. 10: Chemical Waste (biological chemicals, disinfecting chemicals, insecticides) (solid)	Black	Plastic bag
(d)	**Describe impact of solid waste on environment.**			
	1) Attraction of rodent and insects 2) Degrade the environmental quality due to foul odours and unsightliness. 3) Large amount of land utilized for disposing the waste 4) Landfill leachate contaminates surrounding ground and water bodies. 5) Foul gasses create air pollution. 6) Hazardous waste may poses health hazard if not properly handle. 7) E-waste create acidification of soil 8) Chocking of drains and gully pits.			**½ M each**
(e)	**State factors affecting selection of the site for transfer station.**			
	Following factors affecting selection of site for transfer station: 1) Waste scattering / Pollution: It should be selected such that it should not create nuisance to nearby areas. 2) Haul Distance: It should be constructed at suitable locations so as to minimize haul distances. 3) Heritage place: It should be away from heritage place. 4) Traffic flow: It should be located in area where traffic flow is smooth. 5) Electricity: Electricity should be available. 6) Rate of land: It should be located in area where rates of land and property are cheap.			**01 M each (any four)**
(f)	**Describe leachate and its control in landfills.**			
	Leachate: Leachate is the liquid that seeps through solid wastes or other medium and has extracts of dissolved or suspended material from it. Part of the moisture contained in the deposited waste is released under self-weight and flows down. The leachate contains highly polluting TDS, COD, chlorides and heavy metals etc. causing pollution of ground water. Therefore leachate control & removal measures are necessary at landfill sites. **Leachate control are done with different control system using liners as follows:** 1) **Single liner system:** Such system comprises a single primary barrier overlain by leachate collection system with appropriate separation/ protection layer. 2) **Single composite Liner system:** A composite liner comprises two barriers,			**02 M** **01 M each for any two**

	made of different materials, placed in intimate contact with each other to provide a beneficial combined effect of both the barriers. Usually a flexible geo membrane is placed over a clay or soil barrier. 3) **Double Liner system:** In a double liner system a single liner system is placed twice, one beneath other. The top barrier (primary barrier) is overlaid by a leachate system. Beneath the primary barrier another leachate collection system (leak collection layer) is placed by second barrier (secondary barrier).This type of system offers double safety and used for industrial waste landfill.	**methods**
Q.5.	**Attempt any <u>FOUR</u> of the following:**	**16 M**
a)	**Explain vermi composting process and state its concept.**	
Ans:	• Vermicompost is the product or process of composting using various worms, usually red wigglers, to create a heterogeneous mixture of decomposing vegetable or food waste, bedding materials, and vermicast. • **Vermicomposting- Concept** • Take a small wooden box or dig a small pit. • Spread a net on box. • Also spread 1 or 2 cm thick layer of sand. • Put some cow dung and kitchen wastes such as peels of fruits etc., to cover the sand. • Use green leaves to cover over the sand. • Sprinkle some water to make this layer wet. • Get some red worms and put them on the upper layer of bed. • Feed vegetable and fruit wastes as food. • After 3 to 4 weeks we get loose, soil like material in the pit. • Remove the material from the box, dry it in the sunlight. • Use this as manure.	**2M** **2M**
b)	**State various methods of storage of municipal solid waste.**	
Ans:	Mainly the municipal solid waste is expected to store in **two container system** namely **Wet or Biodegradable waste** and **Dry or Non-biodegradable 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 70L. 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.	**1M** **1M each for any three points**

	8) ENCLOSURES an enclosure is probably the most common communal storage method in Asia. Enclosures can have capacities from 1 to 10 m^3 9) FIXED storage bins this type of container usually is built from concrete blocks.	
c)	**Enlist methods of disposal of biomedical waste and explain any one.**	
Ans:	**Biomedical waste management technologies are as follows.** 1. Deep Burrial 2.Autoclaving 3.Microwaving 4.Chemical disinfection 5.Mutilation/Shredding 6. Incineration 7. Secured Sanitary landfills 8. Encapsulation **Disposal of Biomedical waste-** **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 (120-150^oC) and pressure (15-50Psi) 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 cannot 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.	**2M** **2M any one method**

	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	
d)	**Describe purpose of recycling.**	
Ans:	**Purpose of recycling:** i) To save raw material resources in production ii) To save energy in production iii) To reduce solid waste in landfills iv) To minimize environmental pollution v) To reduce the consumption of conventional raw materials. vi) To reduce air pollution from incinerations. vii) To minimize Green house gas emissions.	**1M each for any four point**
e)	**Explain public involvement and participation in solid waste management in India.**	
Ans:	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 play an important role in 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 each for any four point**
f)	**Explain meaning of commercial waste, institutional waste, agricultural waste and domestic waste.**	
Ans:	**1. Commercial waste** Solid wastes that are originate in offices, wholesale and retail stores, restaurants, hotels, markets, warehouses and other commercial establishments. (**And includes food waste, rubbish, ash, C & D waste etc.)** **2. Institutional waste** Institutional waste is waste produced from institutions such as schools, hospitals, or prisons. These are hazardous in some circumstances. (**And includes paper, plastic, cardsheets, C & D waste etc.)** **3. Agriculture waste** This mainly consists of spoiled food grains and vegetables, agricultural	**1M each**

	remains, litter, etc., generated from fields, orchards, vineyards, farms, etc. **4. Domestic waste** The solid wastes that originate from single and multi-family household units. These wastes are generated from household activities such as cooking, cleaning, repairs, hobbies, redecoration, empty containers, packaging, clothing, old books, writing/news paper, and old furnishings.	
Q.6.	**Attempt any <u>FOUR</u> of the following:**	**16 M**
a)	**Define transfer station and state necessity of transfer station.**	
Ans:	**Definition.-** 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 station-** 1) Larger volume of municipal solid waste from urban market is not possible to transport directly to disposal sites for land filling, etc. from collection points. 2) Hence waste is temporarily deposited at some distance away from generation points. At these sites waste is accepted from small collection vehicles. 3) The waste is compacted and loaded into larger vehicles for long haul transports up to disposal site. Thus transfer station results in improvement in collection by minimizing transportation cost, time and reduction in volume.	**1M** **1M each point**
b)	**Describe by products from incineration process and state their uses.**	
Ans:	**Product from incineration process with their use are:-** 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. The **heat** produced during incineration can be used for generating steam which 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.	**1M each**
c)	**Explain methods in collection of recyclables.**	
Ans:	The methods of collection of recyclables are as follows. 1. Curbside collection 2. Buy back centers 3. Drop off centers 4. Deposit Programs **Curbside collection**: In this method the resident in urban or sub urban area sorts recyclable household waste according to type of material in separate bins which are placed on curb side or at collection point weekly or fortnightly which is collected by municipal workers. **Buy back centers:** Buy back centers established at central locations purchase the cleaned recyclable sorted waste from residents. These centers send this collection to recycling factories.	**1M each**

	Drop off centers: The collected recyclables is dropped at reprocessing plants directly. **Deposit Programs:** The resident purchases households after paying deposit amount. After use waste containers are given back to sellers getting back deposit along with bonus point for redemption for next purchase.	
d)	**Define biomedical waste and list its sources of generations.**	
Ans:	**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. **Sources** • Hospital • Health clinic • Nursing home • Research laboratories • Offices of physicians • Dentists • Doctors offices • Veterinary hospitals	**2M** **½ M each (any four)**
e)	**Enlist methods of landfills for solid waste and explain any one.**	
Ans:	**Land filling methods:-** **1**) Area method 2) Trench method 3) Slope method 4) Valley method **1) Area method:-**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. **2) Trench method:-** • 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.	**1/2 M each** **2M (For Any One Method)**

	• 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. **3) Slope Method:-** In hilly regions it is not possible to find flat ground for landfilling, in such situation waste is placed along the sides of existing hill slope. The wastes are spread on existing slope, compacted & covered. The cover materials usually come from just ahead of the working face. **4) Valley Method:-** • At locations where natural or artificial depression exists, it is often possible to use them effectively for land filling operations. • Canyons, ravines, fry borrow pits and quarries have all used for this purpose. • The technique to place and compact solid waste in depression landfills vary with the geometry of the site, the characteristics of the cover material, the hydrology and geology of the site, and the access to the site. ***Note- The student may draw sketch to explain the methods, give appropriate marks to sketch)***	
f)	**Explain various varieties of E-waste.**	
Ans:	**Varieties includes in the E waste are:-** i) **Telecommunication waste**- mobile, Telephones, Monitors and laptops, Mouse, keyboards and other electronic devices, telephone exchange wireless cables and related scrap, Televisions ii) **Electrical Waste** – Switches, relays, connectors and related scrap material iii) **Electronic waste**- Electronic metal waste, Printed Circuits Boards, E – equipment and Machinery, IC, Sockets Connectors iv) **Cable waste**- PVC, Pre insulated Copper and Aluminium Cable waste	**1M each**

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