



WINTER- 17 EXAMINATION

Subject Name: Solid Waste Management

Model Answer

Subject Code:

17605

Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

| Q. No. | Sub Q.N. | Answer | Marking Scheme |
|--------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Q.1 | (i) Ans. | Define Solid Waste Solid waste is defined as "Non soluble material that is thrown away in a solid or semi solid form". This includes: <ul style="list-style-type: none">• Garbage• Refuse• Sludge• Other domestic materials as well as waste from industries, commercial, agricultural and mining operations. | (02 Marks) |
| Q.1 | (ii) Ans. | List types of solid waste Following are the different types of solid waste: <ol style="list-style-type: none">1. Domestic solid waste2. Commercial solid waste3. Industrial solid waste4. Agricultural solid waste5. Institutional solid waste6. Construction and demolition waste7. Market waste8. Biomedical waste9. E - Waste | (02 Marks) For any four |
| Q.1 | (iii) Ans. | List various transportation equipment's in solid waste management system Following are the transportation equipment's / vehicle <ul style="list-style-type: none">• Animal Carts• Auto vehicles• Tractors and trailers• Trucks | (02 Marks) For any four |



| | | | |
|-----|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| | | <ul style="list-style-type: none">• Dumper• Compactor vehicles | |
| Q.1 | (iv) Ans. | List methods of collection of municipal solid waste. Following are the methods of collection of municipal solid waste <ul style="list-style-type: none">• Door to door collection.• Kerb System.• Alley System.• Back yard system.• Hauled container system.• Stationary container system. | (02 Marks) For any four |
| Q.1 | (v) Ans. | List the types of disposal of solid waste Following are the types of disposal of solid waste <ul style="list-style-type: none">• Open burning.• Dumping into the sea.• Sanitary Landfills.• Incineration.• Composting.• Ploughing in fields.• Hog feeding.• Grinding and discharging into sewers. | (02 Marks) For any four |
| Q.1 | (vi) Ans. | State principle of vermin composting. Vermi composting involves the stabilization of organic solid waste through earthworms consumption which converts the material into worm casting. | (02 Marks) |
| Q.1 | (vii) Ans. | State principle of 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 decayed organic matter is called humus. | (02 Marks) |
| Q.1 | (viii) Ans. | Define Biomedical waste. State its components. Defination: “ The waste generated by hospital, nursing or meternity homes, clinics, dispensary, veterinary institutions, pathological laboratory, blood banks which is potentially infectious to human health and the environment is called as biomedical waste” Components: <ul style="list-style-type: none">• Human anatomical waste.• Microbiology and biotechnology waste.• Waste sharps.• Discarded medicines and cyto toxic drugs.• Infectious waste.• Liquid waste generated from any infected area. | (01 Mark) (01 Mark) For any four |
| Q.1 | (ix) Ans. | Enlist Sources of biomedical waste. Sources of biomedical waste <ul style="list-style-type: none">• Hospitals• Health Clinics• Nursing Homes• Medical Research laboratories | (02 Marks) For any four |



| | | | |
|-----|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| | | <ul style="list-style-type: none">• Blood banks• Office of physicians, dentists and veterinarians• Pharmacies | |
| Q.1 | (x) Ans. | State any two features of Biomedical Waste Management of Handling Rule, 1998 Following are the features of Biomedical Waste Management of Handling Rule, 1998 1. Bio-medical waste shall not be mixed with other wastes. 2. Bio-medical waste shall be segregated into containers/bags at the points of generation in accordance with Schedule II prior to its storage transportation, treatment and disposal. The containers shall be labeled according to Schedule III. | (02 Marks) One mark each |
| Q.1 | (xi) Ans. | Write any two precautions to be taken during handling and processing of solid waste. Following are two precautions taken during handling and processing of solid waste 1. Before handling and processing solid waste employees must go through training . 2. Employee must use proper safety aids like hand gloves, goggles etc while handling solid waste. 3. Care must be taken that the waste should not comes in contact with skin. | (02 Marks) For any two |
| Q.1 | (xii) Ans. | Enlist any two methods of mass education in SWM Following are the methods of mass education in SWM <ul style="list-style-type: none">• Use of print media• Use of TV/Cable TV/ Radio/ Web site• Street plays, Puppet show• Posters• Pamphlets• Use of hoarding• Use of public transport system | (02 Marks) For any two |
| Q.1 | (xiii) Ans. | Enlist any two benefits of recycling of solid waste. Following are the benefits of recycling of solid waste <ul style="list-style-type: none">• Reduce the amount of waste sent to landfill and incinerators.• Conserves natural resources such as timber, water and minerals.• Prevents pollution by reducing the need of new raw material.• Saves energy.• Reduce greenhouse gas emissions. | (02 Marks) For any two |
| Q.1 | (xiv) Ans. | State any two steps in recycling solid waste Following are the steps in recycling solid waste. <ul style="list-style-type: none">• Collection and processing• Sorting• Manufacturing• Purchasing new products made from recycled materials• Recycled content product• Recycled product | (02 Marks) For any two |
| Q.2 | (a) | List the characteristics of solid waste. Explain any two characteristics of solid waste along with solid waste management hierarchy. Physical characteristics <ul style="list-style-type: none">• Density | |



| | | |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| | <ul style="list-style-type: none">• Moisture Content• Size• Field Capacity• Permeability of compacted wastes• Porosity <p>Chemical characteristics</p> <ul style="list-style-type: none">• Lipids• Carbohydrates• Proteins• Heating value• Natural fibres <p>Density: Density of waste, i.e., its mass per unit volume (kg/m³), is a critical factor in the design of a SWM system, e.g., the design of sanitary landfills, storage, types of collection and transport vehicles, etc. To explain, an efficient operation of a landfill demands compaction of wastes to optimum density. Any normal compaction equipment can achieve reduction in volume of wastes by 75%, which increases an initial density of 100 kg/m³ to 400 kg/m³. In other words, a waste collection vehicle can haul four times the weight of waste in its compacted state than when it is uncompact. A high initial density of waste precludes the achievement of a high compaction ratio and the compaction ratio achieved is no greater than 1.5:1. Significant changes in density occur spontaneously as the waste moves from source to disposal, due to scavenging, handling, wetting and drying by the weather, vibration in the collection vehicle and decomposition.</p> <p>Moisture content: Moisture content is defined as the ratio of the weight of water (wet weight - dry weight) to the total weight of the wet waste. Moisture increases the weight of solid wastes, and thereby, the cost of collection and transport. In addition, moisture content is a critical determinant in the economic feasibility of waste treatment by incineration, because wet waste consumes energy for evaporation of water and in raising the temperature of water vapour. In the main, wastes should be insulated from rainfall or other extraneous water. We can calculate the moisture percentage, using the formula given below</p> <p>Moisture content (%) = (Wet weight - Dry weight)*100/ Wet weight</p> <p>A typical range of moisture content is 20 to 40%, representing the extremes of wastes in an arid climate and in the wet season of a region of high precipitation. However, values greater than 40% are not uncommon.</p> <p>Size: Measurement of size distribution of particles in waste stream is important because of its significance in the design of mechanical separators and shredders. Generally, the results of size distribution analysis are expressed in the manner used for soil particle analysis. That is to say, they are expressed as a plot of particle size (mm) against percentage, less than a given value.</p> <p>Field capacity: The field capacity of MSW is the total amount of moisture which can be retained in a waste sample subject to gravitational pull. It is a critical measure because water in excess of field capacity will form leachate, and leachate can be a major problem in landfills. Field capacity varies with the degree of applied pressure and the state of decomposition of the wastes.</p> | <p>(01 Mark)</p> <p>(01 Mark)</p> <p>(04 Marks) For any two</p> |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|



Permeability of compacted wastes: The hydraulic conductivity of compacted wastes is an important physical property because it governs the movement of liquids and gases in a landfill. Permeability depends on the other properties of the solid material include pore size distribution, surface area and porosity.

Porosity: It represents the amount of voids per unit overall volume of material. The porosity of MSW varies typically from 0.40 to 0.67 depending on the compaction and composition of the waste. Porosity of solid waste $n = e / (1+e)$ Where e is void ratio of solid waste

Lipids: This class of compounds includes fats, oils and grease, and the principal sources of lipids are garbage, cooking oils and fats. Lipids have high heating values, about 38,000 kJ/kg (kilojoules per kilogram), which makes waste with high lipid content suitable for energy recovery. Since lipids become liquid at temperatures slightly above ambient, they add to the liquid content during waste decomposition. Though they are biodegradable, the rate of biodegradation is relatively slow because lipids have a low solubility in water.

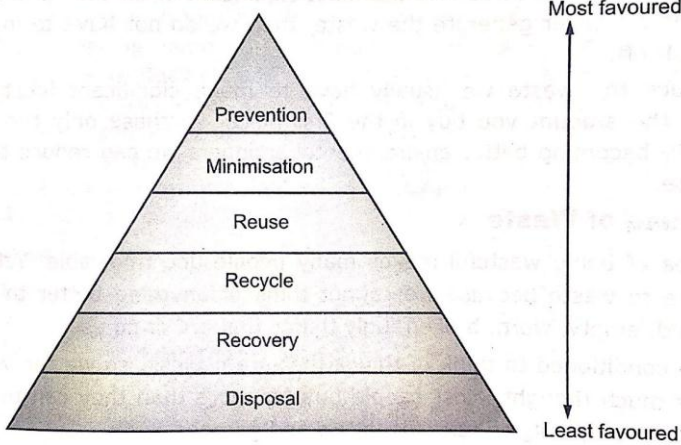
Carbohydrates: These are found primarily in food and yard wastes, which encompass sugar and polymer of sugars (e.g., starch, cellulose, etc.) with general formula $(CH_2O)_x$. Carbohydrates are readily biodegraded to products such as carbon dioxide, water and methane. Decomposing carbohydrates attract flies and rats, and therefore, should not be left exposed for long duration.

Proteins: These are compounds containing carbon, hydrogen, oxygen and nitrogen, and consist of an organic acid with a substituted amine group (NH_2) . They are mainly found in food and garden wastes. The partial decomposition of these compounds can result in the production of amines that have unpleasant odours.

Heating value: An evaluation of the potential of waste material for use as fuel for incineration requires a determination of its heating value, expressed as kilojoules per kilogram (kJ/kg). The heating value is determined experimentally using the Bomb calorimeter test, in which the heat generated, at a constant temperature of 25°C from the combustion of a dry sample is measured. Since the test temperature is below the boiling point of water (100°C), the combustion water remains in the liquid state. However, during combustion, the temperature of the combustion gases reaches above 100°C, and the resultant water is in the vapour form.

Natural fibres: These are found in paper products, food and yard wastes and include the natural compounds, cellulose and lignin, that are resistant to biodegradation. (Note that paper is almost 100% cellulose, cotton over 95% and wood products over 40%.) Because they are a highly combustible solid waste, having a high proportion of paper and wood products, they are suitable for incineration. Calorific values of oven-dried paper products are in the range of 12,000 -18,000 kJ/kg and of wood about 20,000 kJ/kg, i.e., about half that for fuel oil, which is 44,200 kJ/kg.

Waste management hierarchy

| | | | |
|------------|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| | |  | (02 Marks) |
| Q.2 | (b) Ans. | <p>Define transfer station. State the necessity of transfer station. State the factors affecting selection of site for transfer station.</p> <p>Definition : Transfer station are the open or closed structures built by competent authority at various locations in city and waste collected by hauling vehicles in initially transferred to these stations.</p> <p>Necessity of Transfer Station:</p> <ol style="list-style-type: none"> 1. To reduce the haul distance. 2. To Prevent scattering of MSW,thus prevent nuisance due to scattered of solid waste to nearby area. 3. To have ease in proper storage and collection of MSW from different locations. 4.To improve the utilization of collection equipment by minimizing transportation time <p>Factors affecting selection of site for transfer station:</p> <ol style="list-style-type: none"> 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. | <p>(02 Marks)</p> <p>(03 Marks) For any three</p> <p>(03 Marks) For any three</p> |
| Q.2 | (c) Ans. | <p>State the factors affecting composting. State the different methods of composting. Explain any one in detail with neat labeled sketch.</p> <p>Following are the factors affecting composting:</p> <ol style="list-style-type: none"> 1.Organisms 2. Moisture 3. Temperature 4. Aeration 5. Addition of sewage and sludge 6. C/N ratio 7. Particle size 8. pH 9. Blending and seeding | (02 Marks) For any eight |



10. Air circulation

Following are the different methods of composting.

- Manual Composting.
 1. Bangalore method
 2. Indore method
- Mechanical Composting – Dano Process

Bangalore method

This is an anaerobic method of composting. This method saves labour cost because there is no need of turning and regular sprinkling of water.

Procedure:

- Spread the moist farm refuse at the bottom of the pit up to one inch.
- Then, spread two inch of cattle dung and urinated mud followed by 1 or 2 inch layer of soil
- This heap is made up to 1.5-2.0 feet above the ground level following above process.
- Finally the heap is covered with 1 inch thick mud.
- After 8-9 months all material decomposes and compost becomes ready for the application.

Indore method

Procedure:

- First of all, spread dry wastes with cattle dung and soil in ratio of 4:2:1 up to 2 inch layer in Composting pit.
- Afterwards, sprinkle the water over the materials
- Pit is filled with above materials up to 1 foot above the ground level
- One more layer of bedding material with wood ash and urinated mud should be added.
- The material is turned three times for proper aeration and moisture
- **First turning** :10-15 days after filling the pits.
- **Second turning** :15 days after first turning
- **Third turning** :After 2 month of second turning

Mechanical Composting – Dano Process

The process of stabilization is expiated by mechanical device of turning the compost. It require small area as compared to manual composting.

The stabilization takes place I 3-6 days.

The operations involved in mechanical composting are:

- Reception of refuse
- Segregation
- Shredding
- Stabilization
- Marketing

(Students may explain any one method of composting)

**(02
Marks)**

**(04
Marks
for any
one)**



| | | | |
|------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Q.3 | (a) Ans. | <p>State the sources of solid waste. Write impact of solid waste on environment. State the factors affecting generation of solid waste.</p> <p>Sources of solid wastes in the community are:</p> <ol style="list-style-type: none">1. Residential2. Commercial3. Institutional4. Construction and demolition5. Municipal services6. Treatment plant sites7. Industrial8. Agricultural9. Bio medical waste <p>Impact of solid waste on Environment:</p> <p>The decomposition of waste into constituent chemicals is a common source of local environmental pollution. This problem is especially acute in developing nations. Very few existing landfills in the world's poorest countries would meet environmental standards accepted in industrialized nations, and with limited budgets there are likely to be few sites rigorously evaluated prior to use in the future. The problem is again compounded by the issues associated with rapid urbanization. A major environmental concern is gas release by decomposing garbage. Methane is a by-product of the anaerobic respiration of bacteria, and these bacteria thrive in landfills with high amounts of moisture. Methane concentrations can reach up to 50% of the composition of landfill gas at maximum anaerobic decomposition. A second problem with these gasses is their contribution to the enhanced greenhouse gas effect and climate change . Liquid leachate management varies throughout the landfills of the developing world. Leachate poses a threat to local surface and ground water systems. The use of dense clay deposits at the bottom of waste pits, coupled with plastic sheeting type liners to prevent infiltration into the surrounding soil, is generally regarded as the optimum strategy to contain excess liquid. In this way, waste is encouraged to evaporate rather than infiltrate.</p> <p>Following are the factors affecting generation of solid waste:</p> <ol style="list-style-type: none">1. Population2. Urbanization3. Industrialization4. Life style5. Family income6. Size of family7. Climatic condition of the area8. Tourist number.9. Habits and culture of the people10. Source reduction / recycling11. Family income | <p>(02 Marks) For any eight</p> <p>(04 Marks)</p> <p>(02 Marks) For any eight</p> |
| Q.3 | (b) Ans. | <p>State the methods of storage of (MSW) municipal solid waste. State current practice of solid waste management in India in brief.</p> <p>Following are the methods of storage of (MSW)</p> | |



| | | | |
|-----|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| | | <ul style="list-style-type: none">House storage method.Command storage method <p>Current practice of solid waste management in India Generally no bins for the storage of domestic, trade or institutional waste are kept at source. Very few people keep personal bins for the storage of domestic, trade or institutional waste at source. Under the situation most of the domestic waste as well as waste from shops, offices and establishments including hospitals, nursing homes, hotels, restaurants etc., come on the streets or disposed of in unauthorized public or private open plots even discharged into the drain or water bodies resulting in clogging of drains, pollution of water resources and increase in insanitary conditions in the urban areas.</p> | <p>(02 Marks)</p> <p>(Six Marks)</p> |
| Q.3 | (c) Ans. | <p>State the factors affecting selection of site for land filling of solid waste. State the advantages and disadvantages of landfill method. Following are the factors affecting selection of site for land filling</p> <ol style="list-style-type: none">1. Site should be easily approachable.2. It should be located away from the 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>Advantages of Landfill method:</p> <ol style="list-style-type: none">1. Many times landfill is a cheap waste disposal method.2. Jobs will be created for local people.3. Verity of solid waste can be disposed off by landfill method.4. Gases generated from landfill site can be used for heating.5. The site can be re landscaped once it has been filled. <p>Disadvantages of Landfill method:</p> <ol style="list-style-type: none">1. The site will look ugly when it is being used for landfill.2. Dangerous gases are generated from landfill that causes air pollution.3. Local streams could be polluted with leachate seeping through ground from landfill site.4. The jobs created in local area are likely to be low paid jobs.5. The trucks delivering the waste to the site are very big and noisy; they will spoil the peace and quiet in the area. | <p>(04 Marks) For any four</p> <p>(02 Marks) For any four</p> <p>(02 Marks) For any four</p> |
| Q.4 | a) Ans. | <p>i) State the various ways of solid waste prevention and reduction ii) Draw the organization pattern of solid waste management. i) Various ways of solid waste prevention and reduction</p> <ol style="list-style-type: none">1. Purchase items in bulk. Products that are packaged in larger packages typically use less packaging per product than smaller packages. Check this out the next time you are shopping.2. Analyze the size of the packaging for the products you buy. Choose to buy items that use no packaging or a minimal amount of packaging. For example, buy apples from a bin rather than wrapped up on Styrofoam with plastic around them.3. Buy items that are packaged in recycled cartons. This helps to promote recycling.4. Choose to purchase items that are made from recycled products. Most things made from recycled products advertise this fact, so that you know you are helping the | <p>(04 Marks) For any eight</p> |



environment when you purchase them.

5. Recycle items rather than sending them to the landfill. Keep a recycle bin or bag in your home to place plastic, paper and cans. Carry these recycle items to your recycling station. Some towns offer curb side recycling.

6. Place food scraps in a compost bin. You can also use newspaper and other biodegradable items to make compost.

7. Carry cloth bags to the grocery store or market. Use these bags in place of plastic or paper bags that will be thrown away. Reuse the cloth bags each time you shop.

8. Give items to charity or sell in a yard sale rather than throwing them away. Sometimes, 1 person's trash is another person's treasure. This is a wonderful way to recycle items.

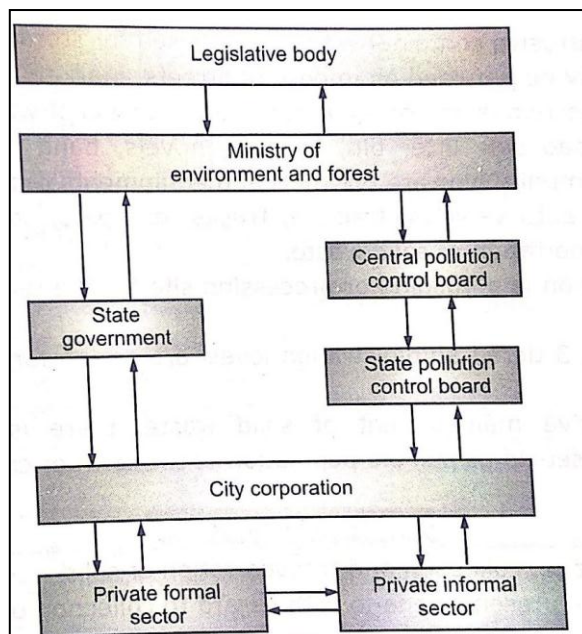
9. Find a way to reuse items rather than throwing them away. An example would be to wash and reuse plastic containers rather than using plastic baggies and throwing them in the trash.

10. Pick up only what you need. Avoid throwing items away unnecessarily. Borrow items that you might only use occasionally. Try to fix an item rather than throwing it away, or see if someone else can fix it for you.

11. Reuse items for a different purpose than originally intended. For example, make a pencil holder out of a metal can.

Recharge batteries rather than using disposable. You will save money in the long run and keep these items out of landfills.

ii) Organization pattern of solid waste management.



(04
Marks)

Q.4

b)
Ans.

Describe the pyrolysis method of incinerations w.r.t. meaning, principle, merits and demerits.

Meaning of pyrolysis: Pyrolysis is also called as destructive distillation or carbonization. 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, CH₄, H₂, C₂H₆] and non combustible Carbon

(02
Marks)



dioxide, Water, Nitrogen [CO₂, H₂O, N₂] gases, pyrolytic liquid, chemicals and charcoal.

Principle 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 absence of oxygen to produce oil.

Merits of Pyrolysis:

1. Reduces greenhouse gases emissions and waste going to landfill.
2. Produces a marketable product like gases, bio-oil, bio-chemicals and charcoal.
2. Low risk of water pollution.
4. Low risk of odour.
5. High recovery rate of resources.
6. Minimal risk of health consequences.

Demerits of Pyrolysis:

1. Less capacity.
2. Less efficiency.
3. More expensive.
4. Market is yet to be developed for char product and pyrolysis liquids.
5. Technology is still evolving.

(02 Marks)

(02 Marks)

(02 Marks)

Q.4

c)
Ans.

Define E-waste. State varieties of E-waste. Explain effect of E-waste on human health and environment.

Definition of E-waste: Electronic waste may be defined as discarded computers, office electronic equipment, entertainment electronic devices, mobile phones, television sets and refrigerator.

This definition includes used electronics and electrical items which are destined for reuse, resale, salvage, recycling.

Varities of E-waste:

| Sr. No. | Type 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.) |

(examples are not necessary)

Effect of E-waste on Human Health

1. Beryllium causing human Carcinogenic(Lung Cancer).
2. Cadmium causing damage to kidney and bones.
3. Lead damage nervous system.
4. Mercury damage central nervous system.
5. Polychlorinated biphenyls liver and reproductive system damage etc.

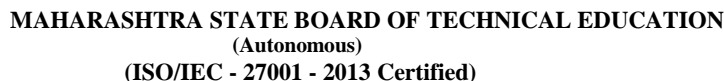
(02 Marks)

(02 Marks)
For any four

(02 Marks)



| | | Effect of E-waste on Environment 1. Pollution of ground water. 2. Air pollution. 3. Acidification of soil. 4. E – waste account for 40 % lead and 75% metal in landfills. | (02 Marks) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|----------|----------------------|---|------------------------------------------------------|--------------------------|---|-------------------------------------------|--------------------------|---|------------------------------------------------------------------|----------------------------------------------|---|------------------------------------------------------------|---------------------------------------------------------------------------------|---|---------------------------------------|--------------------------------------------|---|--------------------------------------------------------------------|----------------------------------------|---|----------------------------------------------------|----------------------------------------------------------------------------|---|-----------------------------------------|-------------------------------------------------|---|------------------|-------------|----|-----------------------------|--------------------------|-----------------------------------------------------|
| Q.5 | a)i Ans | Explain use of by-product of incineration method of solid waste. Use of by-product of incineration method of solid waste are as follows: 1. The heat produced by incineration can be used for steam generation which is finally used for driving turbines for electricity generation. 2. The ash produced by incineration can be used for brick manufacturing. 3. The solidified by-products after incineration having cementing properties can be used for preparation of low grade concrete. 4. The incineration by products can be used as construction filler materials. | 01 mark for each | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Q.5 | a)ii Ans | Explain control measures taken for industrial waste. Control measures taken for industrial waste are as follows: 1. Prevention of Industrial Waste by inventory management of raw materials for purchasing less toxic 7 more nontoxic materials. 2. Use of Modified equipment & optimized production process for less waste production. 3. Installation of alternate recovery or recycling options. 4. Implementation of reuse and exchange of wastes 5. Planning of employee training & management feedback for real commitment. 6. Investment for the pollution prevention techniques. | Any four points. 01 mark for each | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Q.5 | b) Ans | Classify biomedical waste treatment w.r.t. option, category, treatment and disposal. Classification of biomedical waste treatment w.r.t. option, category, treatment and disposal is as follows: <table><tr><th>OPTION</th><th>CATEGORY</th><th>TREATMENT & DISPOSAL</th></tr><tr><td>1</td><td>Human Anatomical Waste(tissues, organs, body parts)</td><td>Incineration/Deep Burial</td></tr><tr><td>2</td><td>Animal Waste(tissues, organs, body parts)</td><td>Incineration/Deep Burial</td></tr><tr><td>3</td><td>Microbiology & Biotechnology Waste (lab cultures, cell cultures)</td><td>Local autoclaving/Micro waving/ Incineration</td></tr><tr><td>4</td><td>Waste Sharps (needles, syringes, scalpels, blades, glass)</td><td>Disinfection/Chemical treatment/ autoclaving/Micro waving/ Mutilation/Shredding</td></tr><tr><td>5</td><td>Discarded Medicines& Cytotoxic Wastes</td><td>Incineration/Destruction/Secured landfills</td></tr><tr><td>6</td><td>Solid Waste (dressings, soiled cotton , plaster, beddings, lines)</td><td>autoclaving/Micro waving/ Incineration</td></tr><tr><td>7</td><td>Solid Waste (tubing, catheters, intravenous sets)</td><td>Disinfection/Chemical treatment/ autoclaving/Micro waving/ drain discharge</td></tr><tr><td>8</td><td>Liquid Waste (lab washing, cleanings,)</td><td>Disinfection/Chemical treatment/Drain discharge</td></tr><tr><td>9</td><td>Incineration Ash</td><td>Landfilling</td></tr><tr><td>10</td><td>Chemical Waste (biological</td><td>Chemical treatment/Drain</td></tr></table> | OPTION | CATEGORY | TREATMENT & DISPOSAL | 1 | Human Anatomical Waste(tissues, organs, body parts) | Incineration/Deep Burial | 2 | Animal Waste(tissues, organs, body parts) | Incineration/Deep Burial | 3 | Microbiology & Biotechnology Waste (lab cultures, cell cultures) | Local autoclaving/Micro waving/ Incineration | 4 | Waste Sharps (needles, syringes, scalpels, blades, glass) | Disinfection/Chemical treatment/ autoclaving/Micro waving/ Mutilation/Shredding | 5 | Discarded Medicines& Cytotoxic Wastes | Incineration/Destruction/Secured landfills | 6 | Solid Waste (dressings, soiled cotton , plaster, beddings, lines) | autoclaving/Micro waving/ Incineration | 7 | Solid Waste (tubing, catheters, intravenous sets) | Disinfection/Chemical treatment/ autoclaving/Micro waving/ drain discharge | 8 | Liquid Waste (lab washing, cleanings,) | Disinfection/Chemical treatment/Drain discharge | 9 | Incineration Ash | Landfilling | 10 | Chemical Waste (biological | Chemical treatment/Drain | Any eight points. 01 mark for each |
| OPTION | CATEGORY | TREATMENT & DISPOSAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Human Anatomical Waste(tissues, organs, body parts) | Incineration/Deep Burial | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Animal Waste(tissues, organs, body parts) | Incineration/Deep Burial | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Microbiology & Biotechnology Waste (lab cultures, cell cultures) | Local autoclaving/Micro waving/ Incineration | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Waste Sharps (needles, syringes, scalpels, blades, glass) | Disinfection/Chemical treatment/ autoclaving/Micro waving/ Mutilation/Shredding | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Discarded Medicines& Cytotoxic Wastes | Incineration/Destruction/Secured landfills | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Solid Waste (dressings, soiled cotton , plaster, beddings, lines) | autoclaving/Micro waving/ Incineration | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Solid Waste (tubing, catheters, intravenous sets) | Disinfection/Chemical treatment/ autoclaving/Micro waving/ drain discharge | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Liquid Waste (lab washing, cleanings,) | Disinfection/Chemical treatment/Drain discharge | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Incineration Ash | Landfilling | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Chemical Waste (biological | Chemical treatment/Drain | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Page No.13/15



| | | | |
|-----|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| | | Monitors, CRT, keyboards, laptops, modems, telephones, hard drives, floppy drives, compact disks, mobiles, fax machines, CPUs, memory chips and cards, connecting 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 & overflowing beyond capacity and due to scarcity of lands it is difficult to get new lands. | 02 marks |
| Q.6 | b) Ans | <p>Define communicable and non-communicable diseases. Discuss the importance of public involvement and participation in SWM.</p> <p>i) The definition of communicable and non-communicable diseases is as follows. Communicable diseases: These are infectious transmissible diseases from person to person by direct contact with an affected individual or his discharges or indirectly by vectors. e.g. diarrhea Non communicable diseases: These are diseases which are not caused by infectious agents hence non transmissible. E.g. hearing defect</p> <p>ii) The importance of public involvement & participation can be described as per following points.</p> <ol style="list-style-type: none">1. To increase the awareness of SWM among the people.2. To promote the principles of Reduction, Reuse, Recycling & Recovery.3. To reduce littering of waste on streets, drains & open spaces.4. To plan segregation of hazardous, non-hazardous; dry wet waste, E waste, BMW & industrial waste.5. To reduce the environmental pollution.6. To increase efficiency of planning & implementation of SWM.7. To improve management strategies with local municipal authorities.8. To encourage composting & recycling initiatives in public & agencies. | 02 marks Any six 01 mark for each |
| Q.6 | c) Ans | <p>State methods of collecting recyclables. Describe current status of recycling of SW in India.</p> <p>The methods of collecting recyclables are as follows.</p> <ol style="list-style-type: none">1. 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.2. 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.3. Drop off centers: The collected recyclables is dropped at reprocessing plants directly.4. 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. <p>The current status of recycling of SW in India is as follows.</p> <ol style="list-style-type: none">1. In India at present repair, reprocess & reuse of waste materials is a common practice in un organized manner.2. Resource recovery is taking place in unrecognized establishments in un organized way.3. At present recycling of dry recyclables is taking place at household levels. | 04 marks 04 marks |



| | | | |
|--|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| | | <p>4. Rag pickers on street, dumping grounds segregate saleable materials such as paper, plastic, glass, metal, textile etc.</p> <p>5. Bhangarwala agents collect dry recyclables from individuals paying some money such as paper, iron, rubber, plastic, glass, furniture, cloths etc.</p> <p>6. These activities are not monitored by government organizations hence it ignores social, economic, and environmental & health aspects.</p> <p>(NOTE: Credit may be given to any other appropriate explanation.)</p> | |
|--|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|