



SUMMER– 18 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.	Answers	Marking Scheme
Q.1	(a) Ans	<p><i>Attempt any five of the following:</i> <i>State any eight impacts of solid waste on environment.</i> Following are the impacts of solid waste on environment.</p> <ul style="list-style-type: none"> i) Major adverse impact is a attraction of rodents and insects. ii) Degrade the environmental quality due to foul odours and unsightliness. iii) Large amount of land utilized for disposing the waste. iv) Leachate in landfill poses a threat to ground water and local sources of water. v) Air pollution from incineration plant. vi) Hazardous waste may poses health hazard if not properly handled. vii) E – waste may causes the acidification of soil. Viii) Choking of drains and gully pits. 	<p>(20)</p> <p>1/2 M for each</p>
Q.1	(b) Ans	<p><i>State the various factors affecting solid waste generation.</i> Following are the factors affecting solid waste generation.</p> <ul style="list-style-type: none"> i) Population ii) Urbanization iii) Industrialization iv) Life style v) Family income vi) Size of family vii) Climatic condition of the area. viii) Tourist number ix) Public attitudes x) Habits and culture of people 	<p>Any eight 1/2 M for each</p>
Q.1	(c) Ans	<p><i>Explain in brief about organization pattern of solid waste management according to the population of city.</i> Organizational set up Tows below 1,00,000 population.</p>	



- One qualified diploma holder Sanitary officer (SO) if population is more than 50,000
- One qualified Sanitary Inspector (SI) if population is @50,000
- One qualified Sub Sanitary Inspector (SSI) if population is @25,000
- One sanitary supervisor (SS) @12,500 population

Cities between 1 to 2 Lacs population.

- Public health/Environmental/Civil Engineer in the grade of Assistant Engineer to be incharge of SWM department.
- One qualified diploma holder Sanitary officer (SO) , one (SO) per one lakh population.
- One qualified Sanitary Inspector (SI),@ 1 (SI) per 50,000 population.
- One qualified Sub Sanitary Inspector (SSI),@ 1 (SSI) per 25,000.
- One sanitary supervisor (SS), 1 SS @12,500 population

Cities between 2 to 5 Lacs population.

- Public health/Environmental/Civil Engineer in the grade of Assistant Executive Engineer to be incharge of SWM department.
- Public health/Environmental/Civil Engineer in the grade of Assistant Engineer to look after the transportation , processing and disposal of waste
- One qualified diploma holder Sanitary officer (SO) , one (SO) per one lakh population.
- One qualified Sanitary Inspector (SI),@ 1 (SI) per 50,000 population.
- One qualified Sub Sanitary Inspector (SSI),@ 1 (SSI) per 25,000.
- One sanitary supervisor (SS), 1 SS @12,500 population

Cities between 5 to 20 Lacs population.

- Public health/Environmental/Civil Engineer in the grade of Executive Engineer to be incharge of SWM department.
- Public health/Environmental/Civil Engineer in the grade of Assistant Executive Engineer ,@ 1 for 5 Lakh population
- Public health/Environmental/Civil Engineer in the grade of Assistant Engineer to look after the transportation , processing and disposal of waste, @ 1 for 2.5 Lakh population
- One qualified diploma holder Sanitary officer (SO) , one (SO) per one lakh population.
- One qualified Sanitary Inspector (SI),@ 1 (SI) per 50,000 population.
- One qualified Sub Sanitary Inspector (SSI),@ 1 (SSI) per 25,000.
- One sanitary supervisor (SS), 1 SS @12,500 population

Cities between 20 to 50 Lacs population.

- Public health/Environmental/Civil Engineer in the grade of Superintending Engineer to be incharge of SWM department.
- Public health/Environmental/Civil Engineer in the grade of Executive Engineer ,@ 1 for 20 Lakh population
- Public health/Environmental/Civil Engineer in the grade of Assistant Executive Engineer ,@ 1 for 5 Lakh population

Any two
02 M for
each



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Q.1	(d) Ans	<p><i>State the factors affecting compo sting process.</i></p> <p>Following are the factors affecting composting process</p> <ul style="list-style-type: none">i) Organismii) Moisture contentiii) Temperatureiv) Aerationv) Addition of sewage and sewage sludgevi) Use of culturesvii) C/N ratioviii) Particle sizeix) pHx) Blending and seedingxi) Air circulation.	Any eight 1/2 M for each
Q.1	(e) Ans	<p><i>Explain about any four effects of biomedical waste.</i></p> <p>Following are the four effects of biomedical waste</p> <p>Wildlife and Pharmaceuticals</p> <p>Biomedical waste that is not disposed of properly can end up in lakes, parks, and other wildlife refuges where birds and fauna live. Wildlife are very curious about pharmaceuticals. It is thought they are attracted to the scent or color of pills and liquid medicine. This curiosity results in digestion of medication, which can injure or even kill the animal.</p>	



		<p>industrial processes.</p> <p>iii) Agricultural waste: Waste produced by various farming activities like dairy farming, horticultural, seed growing, livestock breeding, market gardens, nursery plots, woodlands etc is known as agricultural waste.</p> <p>iv) Institutional waste: Waste generated at institutions such as schools, libraries, hospitals etc is known as institutional waste.</p>											
Q.2	(b) Ans	<p><i>Differentiate between hazardous and nonhazardous solid waste.</i></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Hazardous Waste</th> <th style="width: 50%;">Non Hazardous Waste</th> </tr> </thead> <tbody> <tr> <td>Waste either ignitable, corrosive, reactive, infectious or toxic or combination of these is called as hazardous waste</td> <td>Waste which is not potential threat to public health and environment.</td> </tr> <tr> <td>Requires special management considerations because the treatment method for one of the hazards may be inappropriate for the treatment of another.</td> <td>Simple treatment and disposal methods can be used for all types of non-hazardous waste like landfilling.</td> </tr> <tr> <td>Cost of treatment and disposal of waste is more.</td> <td>Treatment and disposal coast is less.</td> </tr> <tr> <td>Examples: Industrial waste, E-Waste, Bio medical waste.</td> <td>Examples: Food waste, plastic bags, tin cans etc.</td> </tr> </tbody> </table>	Hazardous Waste	Non Hazardous Waste	Waste either ignitable, corrosive, reactive, infectious or toxic or combination of these is called as hazardous waste	Waste which is not potential threat to public health and environment.	Requires special management considerations because the treatment method for one of the hazards may be inappropriate for the treatment of another.	Simple treatment and disposal methods can be used for all types of non-hazardous waste like landfilling.	Cost of treatment and disposal of waste is more.	Treatment and disposal coast is less.	Examples: Industrial waste, E-Waste, Bio medical waste.	Examples: Food waste, plastic bags, tin cans etc.	01 M for each point
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Examples: Industrial waste, E-Waste, Bio medical waste.	Examples: Food waste, plastic bags, tin cans etc.												
Q.2	(c) Ans	<p><i>Explain in brief the present scenario with regard to collection of municipal solid waste.</i></p> <p>According to Municipal Waste Management Rules (2000), it is the responsibility of municipalities to prohibit littering of solid waste in cities, towns and in urban areas notified by governments. To facilitate compliance, municipal authority have to organize house to house collection through any of the methods:</p> <ul style="list-style-type: none"> ●Community bin collection ●House to house collection ●Collection on regular time interval (which must be pre-informed) ●Scheduling by using bell ringing of musical vehicle (without exceeding the noise levels) <p>To increase collection efficiency, the integration of these methods is required. The transportation of municipal solid waste is generally carried out twice in a week or weekly basis by container carriers. However, in small towns and rural areas, open trucks, dumper trucks are used for waste collection. In recent times, with support of NGO and local communities, waste collection efficiency has increased remarkably in few rural areas. Since collection costs are 50-70% of solid waste budget, it is the most significant area for cost reductions. Interrelated variables such as labor costs, crew size, union restrictions, collection frequency, distance (travel time) to disposal and performance and annual costs of equipment must be considered during planning stage.</p> <p>Many local bodies have taken initiative for efficient waste collection along with certain</p>	04 M										



		<p>Poorly managed waste serves as a breeding ground for disease vectors, contributes to global climate change through methane generation, and even promotes urban violence. Managing waste properly is essential for building sustainable and livable cities, but it remains a challenge for many developing countries and cities. Effective waste management is expensive, often comprising 20%–50% of municipal budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported.</p> <p>(Students may explain in different manner appropriate marks should be given for the relevant explanation)</p>									
Q.3	(b) Ans	<p>State the methods of provisions of Litter bin on streets and public places.</p> <p>Litters bins are provided by keeping in minds following points:</p> <ul style="list-style-type: none"> i) Litter bins shall be placed at the sides of road/pavements so that person willing to throw the waste can use it. ii) Litter bin shall be good looking. iii) The frame shall be grouted for rigidity and security. iv) Bins shall be hanged on the frame at suitable height so that public can easily put the waste and it can be easily unloaded by swinging. v) Litter bin should be of sufficient capacity. 	Any four 01 M each								
Q.3	(c) Ans	<p>Enlist the methods of land filling of solid waste. Explain in brief about anyone method.</p> <p>Following are the methods of landfilling.</p> <ul style="list-style-type: none"> i) Area method ii) Trench method iii) Ramp or slope method <p>Area method The area method is best suited for flat or gently sloping areas where some land depressions may exist. The wastes are spread, compacted and then covered with material which may need to be hauled in from adjacent areas.</p> <p>Trench method The trench method consists of an excavated trench into which the solid wastes are spread, compacted and covered. The trench method is best suited for nearly level land where the water table is not near the surface. Usually the soil excavated from the trench is used for cover material.</p> <p>Ramp or slope method The slope or ramp is sometimes used in combination with the other two methods. The wastes are spread on an existing slope, compacted and covered. This variation may be suitable for most areas. The cover materials usually come from just ahead of the working face.</p>	02 M Any one 02 M								
Q.3	(d) Ans	<p>State the products of incineration process of solid waste and also state their uses.</p> <p>Following are the products of incineration process with their uses.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Products of incineration</th> <th style="width: 50%;">Uses</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Heat</td> <td>Can be used for electricity generation.</td> </tr> <tr> <td style="text-align: center;">Solidified outputs</td> <td>After incineration process left out products can be used as aggregate for low grade concrete.</td> </tr> <tr> <td style="text-align: center;">Incineration Ash</td> <td>Used for making bricks or blocks. Can be used as a filler material.</td> </tr> </tbody> </table>	Products of incineration	Uses	Heat	Can be used for electricity generation.	Solidified outputs	After incineration process left out products can be used as aggregate for low grade concrete.	Incineration Ash	Used for making bricks or blocks. Can be used as a filler material.	04 M
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Q.4	(d) Ans	<p>Define - Biomedical waste and write down its components.</p> <p>Definition; The waste generated by hospitals, nursing or maternity homes, clinics, dispensary, veterinary institutions, pathological labs, blood banks which is potentially infectious to human health and environment is called as “Biomedical waste”.</p> <p>Components of Biomedical waste:</p> <ul style="list-style-type: none">i) Human anatomical waste (Tissues, organ, body parts etc.)ii) Animal waste (Tissues, organ, body parts etc.)iii) Microbiology and biotechnology waste.iv) Waste sharpsv) Discarded medicines and cyto toxic drugs.vi) Infectious wastevii) Chemical wasteviii) Cytotoxic wasteix) Radioactive waste	02 M Any four 02 M for each
Q.4	(e) Ans	<p>Enlist the varieties of industrial solid waste. Explain in brief.</p> <p>Following are the varieties of industrial solid waste:</p> <ul style="list-style-type: none">i) Cinderii) Sludgeiii) Slagiv) Waste plasticsv) Waste metalvi) Waste glass, waste concrete, waste ceramicsvii) Slagviii) Rubble <p>Cinder Coal ash, incineration residue, active charcoal, ash from incinerator, and other cinders</p> <p>Sludge Various kinds of muddy substance, such as sludge from drainage treatment and construction</p> <p>Slag Foundry sand, waste from sand blast, low-quality coal, various wastes from blast furnace, etc.</p> <p>Waste plastics Waste styrene foam, waste synthesized fibers, and all other synthesized polymers (solid, liquid) including synthesized rubber</p> <p>Waste metal Waste iron, waste aluminum, and other waste metals generated in polishing, cutting, etc.</p> <p>Waste glass, waste concrete, waste ceramics Plate glass, waste fireproof brick, plaster board, waste concrete from a process to produce concrete product, etc.</p>	02 M Any four 1/2 M for each



		Rubble Concrete pieces, brick pieces, etc. generated in the construction, reconstruction or removal of structure.	
Q.4	(f) Ans	State the health problems that may be faced during segregation, reuse, recovery and recycling of solid waste. Following are the health problems that may be faced during segregation, reuse, recovery and recycling of solid waste i) Low birth rate ii) Cancer iii) Neurological diseases iv) Nausea and vomiting v) Increase in hospitalization of diabetic resident living near to waste site vi) Chemical poisoning through chemical inhalation.	Any four 01 M for each
Q.5	(a) Ans.	Attempt any four of the following: Define transfer station. State about its necessity and criteria of location of transfer station. Transfer station: - It is defined as a processing site for temporary deposition of waste prior to loading into larger vehicles, from this site larger vehicles transport the municipal solid waste to disposal site for landfilling. Necessity of Transfer station: - Larger volumes of MSW from urban markets is not possible to transport directly to disposal sites for land filling etc. from collection points hence they are temporarily deposited at some distance away from generation points. At these sites waste is accepted from small collection vehicles. Then it is consolidated compacted & loaded into large vehicles for long haul transports up to disposal sites. This operation improves the utilization of collection equipment by minimizing transportation time & efficiently moving large volumes of waste to disposal sites. Criteria of location of Transfer Station: - following points are considered for location of Transfer Station. 1. It should be centrally located. 2. It should not be far away from disposal sites. 3. It should be in areas where traffic flow is smooth. 4. It should not be in thickly populated areas or residential areas.	(16) 01 M 01 M Any two 01 M for each
Q.5	(b) Ans.	Explain about Bangalore method of manual composting of solid waste. 1. This is anaerobic method conventionally carried out in pits manually. 2. The pit is prepared by laying alternate layers of municipal solid waste and putrescible waste or night soil. 3. The pit is completely filled and final soil layer is laid to prevent fly breeding, entry of rain water into pit and conservation of released energy. 4. The turning of waste and use of any mechanical means is not done. 5. The waste is allowed to decompose for 4 to 6 months after which the stabilized material is taken out to be used as compost. 6. This method needs larger land space. 7. The gases generated in this method produce smell & odor problems. 8. This method requires longer time for stabilization of Waste.	1/2 M for each.

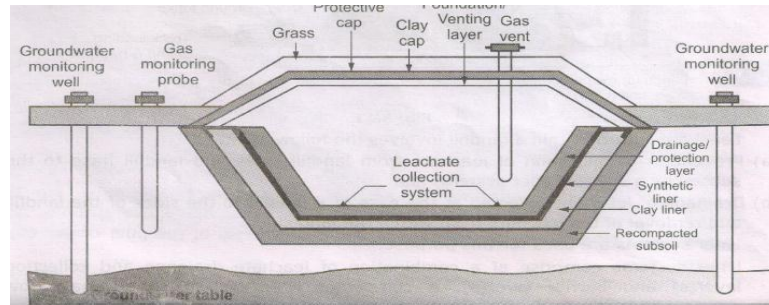


Q.5	(c) Ans.	Explain about varieties of E-Waste stating its sources of generation.																												
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Q.5	(d) Ans.	State the control measures to be adopted about industrial solid waste regarding its generation, collection and adverse effects. Control measures of Industrial waste regarding generation, collection and adverse effects are as follows. <ol style="list-style-type: none">1. Inventory management for raw materials tracing, purchasing & storing practices.2. Modification of equipment causing minimum waste improving efficiency with proper maintenance programme.3. Production process changes with improved operations using non-hazardous raw materials.4. Reduction in waste generation at source by simple measures.5. Reuse and Recycle techniques by installing closed loop systems & exchange of wastes.6. Initial investment for pollution prevention project installing conventional equipment.7. Practicing waste minimization by careful planning, creative problem solving, and attitude changing & capital investment.8. Implementation of employees training & management feedback.	1/2 M for each.																											
Q.5	(e) Ans.	State the measures to be taken to bring about a change in public for solid waste management w.r.t. '3R' strategy. Measures to be taken to bring about a change in public for solid waste management w.r.t. '3R' strategy are as follows. <ol style="list-style-type: none">1. Promotion of Reduce Reuse & Recycle Techniques through Manufacturers, NGOs etc.2. Promoting Public participation in SWM systems adopted regarding collection, Segregation & storage of house hold waste.3. Public education using print media, TV, Cinema, posters, pamphlets, hoarding, transport system, school children curriculum, NCC, Leaders involvements in Rallies etc.4. Enforcement at public places, market places, Exhibitions , private functions etc.	01 M for each.																											
Q.5	(f) Ans.	Explain in brief present status of solid waste recycling in India. The rules in India require municipalities to ensure community participation in waste segregation by not mixing wet food wastes with dry recyclables like paper, plastics, glass	04 M																											



		metal etc. and to promote recycling or reuse of segregated materials. In India there is no formal recycling system but informal recyclers are there and play an important role in solid waste management. These comprises of unorganized and unrecognized establishments which are difficult to be monitored by government agencies. However resource recovery through material recycling is taking place in India in a big way through unorganized ways. Material recycling is done through sorting of waste into different streams at the source or at a centralized facility. Sorting at source is more economical than sorting at a centralized facility.	Credit may be given to similar explanation.														
Q.6	(a) Ans.	<p>Attempt any two of the following: Explain in detail about Biomedical waste management and handling as per Rule 1998.</p> <p>Biomedical waste management & handling rules 1998 were notified by the Ministry of environment & Forests in July 1998. According to this safe disposal of biomedical waste is a legal requirement in India. According to these rules it is the duty of every occupier i.e. a person who has the control over the institution or its premises to take all steps to ensure that waste generated is handled without any adverse effect to human health and environment. The hospitals, nursing homes, clinics, pathological labs etc. are required to set in place the biological waste treatment facilities. It is necessary to ensure that the waste is treated within a period of 48 hours. The six schedules of BMW management are as given below.</p> <table border="1"> <thead> <tr> <th>Schedule</th> <th>Contents</th> </tr> </thead> <tbody> <tr> <td>I</td> <td>Classification of biomedical waste in various categories should be done.</td> </tr> <tr> <td>II</td> <td>Color coding and different types of containers should be used for each category of biomedical waste.</td> </tr> <tr> <td>III</td> <td>Proforma of the label should be used on containers/bags.</td> </tr> <tr> <td>IV</td> <td>Transport of Biomedical waste should be done in vehicles having biohazard symbols.</td> </tr> <tr> <td>V</td> <td>Standards for treatment and disposal of biomedical waste should be used.</td> </tr> <tr> <td>VI</td> <td>Deadline for creation of waste treatment facilities should be specified.</td> </tr> </tbody> </table>	Schedule	Contents	I	Classification of biomedical waste in various categories should be done.	II	Color coding and different types of containers should be used for each category of biomedical waste.	III	Proforma of the label should be used on containers/bags.	IV	Transport of Biomedical waste should be done in vehicles having biohazard symbols.	V	Standards for treatment and disposal of biomedical waste should be used.	VI	Deadline for creation of waste treatment facilities should be specified.	(16) 02 M 06 M
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Q.6	(b)(i) Ans.	<p>Define Leachate. State the necessity to control it.</p> <p>Leachate is defined as a contaminated liquid containing different dissolved & suspended material which comes out through solid waste mass. It is generated out due to infiltration of rainfall water into landfills & its percolation through waste and squeezing out due to self-weight.</p> <p>The leachate control is necessary due to following reasons.</p> <ol style="list-style-type: none"> 1. Problems including clogging with mud or silt. 2. Growth of microorganisms in the conduit. 3. The chemical composition of leachate can weaken pipe walls which may then fail. 4. The percolation of leachate will cause the soil pollution. 5. It will contaminate the shallow ground water source in rainy season. 6. It affects the DO content water which is harmful to aquatic life. 7. It will lead to waterborne diseases. 	01 M Any three 01 M for each														
Q.6	(b)(ii) Ans.	<p>Explain with neat sketch about single composite liner system and double liner system for the leachate control.</p> <p>Single Composite liner System: - A composite liner consist of two barriers , 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</p>	01 M														

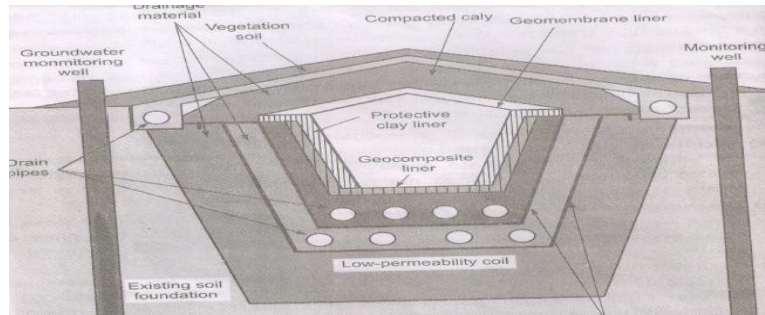
clay or amended soil barrier. A leachate collection system is placed over the composite barrier. Single composite liner systems are often the minimum specified liner system for nonhazardous wastes such as MSW.



01 M

Double liner System: - In a double liner system a single liner system is placed twice, one beneath the other. The top barrier called as primary barrier is overlaid by a leachate collection system. Beneath the primary barrier another leachate collection system called as leak detection layer is placed followed by a second barrier i.e. secondary barrier. This type of system offers double safety and is often used for industrial waste landfills. It allows the monitoring of any seepage which may escape the primary barrier layer.

01 M



01 M

Q.6 (c)(i)
Ans.

State the various benefits of recycling of solid waste.

The benefits of recycling of solid wastes are as given below.

1. Reduces amount of waste sent to landfills & incineration.
2. Conserves natural resources as timber, water, minerals.
3. Prevents pollution by reducing use of new raw materials.
4. Saves energy.
5. Helps to sustain environment.
6. Reduces global warming effect.
7. Creates employment in new jobs.

Any four
01 M for each.

Q.6 (c)(ii)
Ans.

Explain about various methods of collection of recyclable materials (solid waste).

1. Curb side collection: It is a service provided to households in urban areas. In this method the resident sorts their domestic waste according to type of material in specially provided bins. These are placed curb side for collection on fortnightly basis.
2. Buy Back centers: The recyclers bring the cleaned recyclables to a central location at buy back centers where they are purchased. Due to incentives provided to recyclers a stable supply of recyclables is ensured.
3. Drop off centers: These centers require the recyclers to bring the recyclables to a central location at installed, mobile collection center or reprocessing plant itself.

01 M for each.



		<p>This form of recycling waste collection is the easiest to establish. However since the use of such centers is on a voluntary basis it often suffers from low and unpredictable supply of recyclables.</p> <p>4. Deposit programs: In this system customers pay an additional fee when purchasing containers but receive fee once they return container to the purchaser point. As an incentive the deposit container program places a certain amount as redeemable deposits on each container. Customers get back their amount when they return their container to a redemption center.</p>	
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