

**AP® ENVIRONMENTAL SCIENCE
2016 SCORING GUIDELINES**

Question 3

Municipal solid waste (MSW) is the trash collected from households and businesses.

- (a) Use the data provided in the graph to respond to the following.
- (i) **Explain** one probable cause (other than increased composting) for the change in per capita waste generation from 2000 to 2012.
(1 point for a correct explanation for the change in per capita generation from 2000 - 2012)
- People or businesses practicing one of the following: refuse, reduce, reuse, recycle, or repurpose.
 - Lighter materials contribute to less MSW creation (e.g. plastic bottles not glass bottles)
 - Less material used in products (newspapers smaller, aluminum cans less massive)
 - Technology reduces waste generation (e.g., reading magazines online → less paper)
 - Economic recession → less consumption → less MSW produced
- (ii) **Calculate** the percent increase in total MSW generation from 1980 to 2012.
(1 point for the correct answer with work shown)

$$\frac{(250 \text{ million tons} - 150 \text{ million tons})}{150 \text{ million tons}} \times 100 = 66\% \text{ to } 67\%$$

- (b) Two ways of managing MSW are incineration and disposal in landfills.
- (i) **Identify** one disadvantage of waste incineration.
(1 point for a correct identification of a disadvantage of waste incineration)
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| <ul style="list-style-type: none"> • Specific air pollutant (e.g., CO, CO₂, dioxin, halogens, particulates, SO_x, NO_x) • Ash disposal necessary • Incinerator is expensive to construct and/or operate | <ul style="list-style-type: none"> • MSW supply and quality may be limited requiring additional fuel • Reduced quality of life and property value due to incinerator and supply trucks |
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- (ii) **Identify** one disadvantage of waste disposal in landfills.
(1 point for a correct identification of a disadvantage of waste disposal in landfills)
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| <ul style="list-style-type: none"> • Ground water, surface water, or soil contamination through some transport mechanism • Reduced quality of life and property value due to landfill and supply trucks | <ul style="list-style-type: none"> • Release of methane or CO₂ • Odor source • Attracts vermin • Habitat destruction • Preclusion of other land uses • Explosion/seepage hazard from methane produced |
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Question 3 (continued)

Trash incineration is one way to generate electricity from MSW. Electricity can also be generated from waste buried in landfills.

- (c) **Describe** the specific steps of a process use to produce electricity from waste buried in a landfill.
(3 points – 1 point for each step in the process of generating electricity from landfill gas)

Step	Description of Step
Acquire fuel (chemical energy)	Methane collected or gathered
Use fuel (chemical → mechanical)	Fuel is combusted to produce steam or hot air
Generate electricity (mechanical → electricity)	Steam or hot air spins/turns/rotates a turbine/generator to generate/produce electricity

- (d) Many landfills do not accept used tires. As a result, the tires are often dumped in poorly regulated piles. **Describe** one human health problem associated with piles of discarded tires.
(1 point for a correct description of a human health problem associated with piles of discarded tires)
- Discarded tires provide habitat for mosquitoes/pests that can be disease vectors.
 - Tires may catch fire and release air pollutants that cause respiratory issues in humans.
- (e) Composting is one way to reduce the amount of waste that enters a landfill.
- (i) Other than reducing the volume of waste, **identify** one advantage of composting.
(1 point for a correct identification of an advantage of composting)
- The resulting compost can be used or sold as fertilizer or soil amendments.
 - Municipal composting facilities may provide jobs.
 - MSW may emit less foul odor if organic material is composted.
 - Tipping fees and trash removal costs may be reduced due to removal of dense compostable material.
- (ii) **Identify** one disadvantage of composting.
(1 point for a correct identification of a disadvantage of composting)
- Compost may attract undesirable animals (vermin).
 - Compost may emit foul odors or spontaneously combust.
 - Nutrients released from decomposing organic matter may run off into surface waters and cause water quality problems.
 - Compost may release methane.
 - Composting organic material requires a great investment of time and labor by humans.