2021

AP® Environmental Science

Free-Response Questions
Set 1

ENVIRONMENTAL SCIENCE

SECTION II

Time—1 hour and 10 minutes

3 Questions

Directions: Answer all three questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers in the Free Response booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. You may plan your answers in this orange booklet, but no credit will be given for anything written in this booklet. **You will only earn credit for what you write in the separate Free Response booklet.**

1. A homeowner in the Northern Hemisphere is considering installing photovoltaic (PV) panels on the roof of the home to help provide electricity for the home. The homeowner has read conflicting reports on which compass direction the panels should face to maximize the amount of electricity (in kWh) that the panels can produce.

   (a) The homeowner plans to design an experiment to determine the direction of the panels for maximal electricity production.

   (i) **Identify** the independent variable in the experiment.

   (ii) **Identify** the dependent variable in the experiment.

   (iii) **Identify** a reasonable hypothesis for the experiment.

   (iv) **Describe** one variable that was not discussed that could affect the results of the study.

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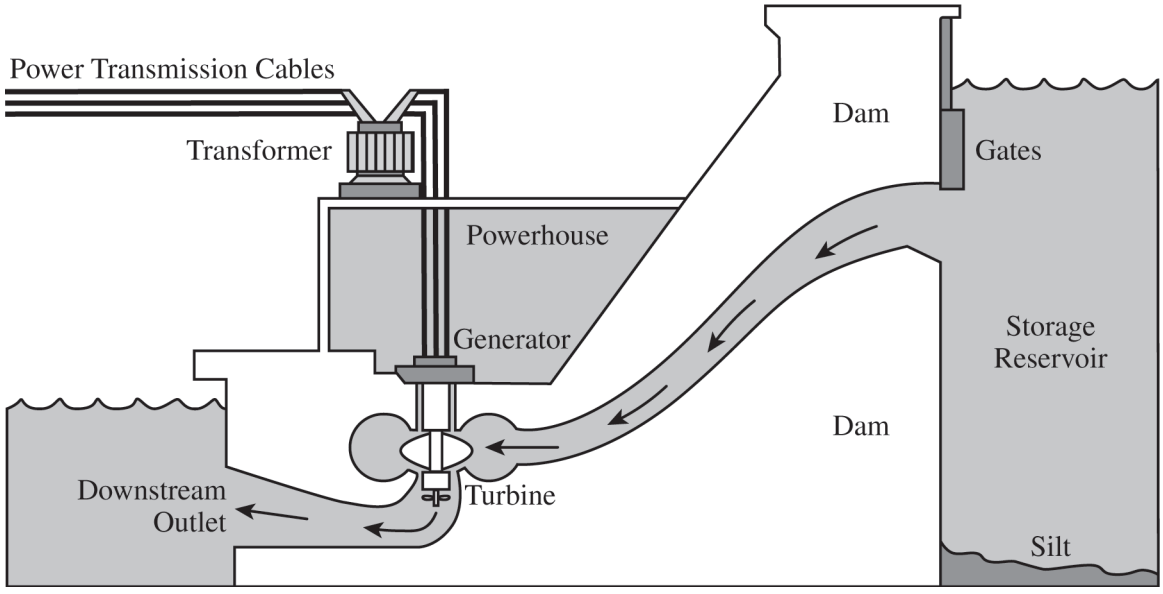
(b) The diagram below shows another way of generating electricity using a renewable resource. The arrows indicate the flow of water.

HYDROELECTRIC POWER GENERATION



(i) **Identify** the location shown in the diagram where the kinetic energy of the water is transformed into mechanical energy.

(ii) **Explain** why the water in the storage reservoir has potential energy that is useful in hydroelectric power generation.

(iii) **Explain** how coupling hydroelectric power with solar or wind power is an advantage to providing a constant source of electricity to a community.

(iv) **Explain** how a hydroelectric power system, like the one depicted, may be negatively affected by climate change.

(c) Over time, reservoirs that form behind dams can undergo changes.

(i) **Identify** one advantage, other than the generation of hydroelectric power, of the formation of a reservoir behind a hydroelectric dam.

(ii) **Explain** the effect of increased silt in the reservoir on the hydroelectric power system.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

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2. Pesticides have been utilized for many years to increase food production and control pest populations. Pesticide use can be both beneficial and harmful to humans and other organisms.

(a) Pesticide use has advantages, disadvantages, and unintended consequences on human health. **Describe** one benefit to human health that can result from the use of pesticides.

(b) **Identify** one way chemical pesticides can enter the human body.

Cotton farmers in the southern United States used a chemical pesticide to control an insect cotton-crop pest over a 40-year period. To study the effectiveness of the pesticide as an insect pest-control strategy, traps were placed in treated cotton fields and the number of pests captured were compared to application rates for the pesticide. The results of the study are shown in the table below.

Year	Grams of Pesticide Applied per Hectare	Number of Crop Insect Pests Captured
1960	0	700
1975	500	2
1980	500	3
1985	500	8
1990	550	14
1995	600	83
2000	700	150
2005	800	405
2010	900	727
2015	1,000	1,100

(c) Use the data in the table to answer the following questions.

(i) **Identify** the year when the pesticide was most effective at reducing the size of the pest population.

(ii) **Describe** the change in the number of crop insect pests in the cotton fields over time.

(iii) **Explain** how the change in the cotton-crop pesticide effectiveness between the initial application in 1975 and the latest application in 2015 illustrates genetic resistance in pests, based on the data in the table.

(d) **Describe** TWO effects of pesticide use, other than death, on nontarget wildlife.

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(e) There are many problems associated with the repeated application of chemical pesticides to reduce pest populations.

(i) Crop rotation is often used to reduce pesticide use. **Describe** the process of crop rotation.

(ii) **Propose** one reasonable method, other than crop rotation, of reducing the use of pesticides in agricultural practices while still maintaining a high crop yield.

(iii) **Justify** how the method proposed in (e)(ii) would provide a benefit to humans.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

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3. Habitat destruction and fragmentation can have many different effects on species.

(a) **Describe** a characteristic of a specialist species that would make the specialist species more likely to be negatively affected by habitat fragmentation than a generalist species.

A rapidly growing suburban municipality purchases nearby forested land and proposes a newly planned housing development, which would involve clear-cutting much of the area for the construction of single-family homes. While evaluating the land, the development committee discovers that development will encroach upon the habitat of a wood thrush population. The wood thrush is a solitary, territorial bird whose preferred habitat consists of large, intact densely forested areas. Wood thrush populations are also threatened by cowbirds. A cowbird lays her egg in an existing nest of a wood thrush. After the cowbird egg hatches, the cowbird pushes the unhatched wood thrush eggs out. The wood thrush parents raise the cowbird hatchling as their own.

(b) **Identify** the symbiotic relationship between the wood thrush and the cowbird.

(c) **Describe** one ecological advantage of leaving areas of undeveloped forest in the development plan as compared to clear-cutting the property.

(d) **Propose** a solution that will minimize the effect of development on the resident population of wood thrush while still meeting the municipality's need for a housing development.

(e) A male wood thrush needs a minimum of $800\,m^2$ of territory for reproduction. The municipal development committee has set a biodiversity preservation target of 275 male wood thrush territories. **Calculate** the area that must be set aside to support the goal of 275 male thrush territories. **Show** your work.

(f) A real estate developer wants to build houses on the property. The plan will support 1,000 lots with a lot size of $1{,}100\,m^2$. The developer has proposed setting aside land equal to 10% of the size of each lot it sells. **Calculate** the maximum number of male wood thrush territories that could be created under this proposal. **Show** your work.

(g) **Calculate** the percentage of each of the 1,000 lots that would need to be set aside in order to support the goal of 275 male wood thrush territories. **Show** your work.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

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END OF EXAM