2021

AP® Environmental Science

Scoring Guidelines

Set 1

Question 1: Design an Investigation — 10 points

(a) (i) **Identify** the independent variable in the experiment. **1 point**

- Direction the panels face

(ii) **Identify** the dependent variable in the experiment. **1 point**

- Amount of electrical energy produced

(iii) **Identify** a reasonable hypothesis for the experiment. **1 point**

Accept one of the following:

- If the photovoltaic panels face north/south/east/west, then the maximum amount of electricity will be produced.
- The position (compass direction) of solar panels will affect how much energy is produced.
- Solar panels positioned with greatest access to the sun will generate more energy.
- The compass direction the panels face will not have an effect on the amount of electricity produced.

(iv) **Describe** one variable that was not discussed that could affect the results of the study. **1 point**

Accept one of the following:

- Panels tilted to an improper angle that does not match the position of the sun will decrease energy/kWh production.
- Shade or shadows from trees, dust, clouds or snow on the panels would prevent absorption of sunlight, decreasing energy/kWh production.
- Seasonal or daily variations in solar intensity will lead to an increase or decrease in energy/kWh production.
- Cooler temperatures produce more kWh because heat decreases the efficiency of solar panels.

Total for part (a) **4 points**

(b) (i) **Identify** the location shown in the diagram where the kinetic energy of the water is transformed into mechanical energy. **1 point**

- Turbine

(ii) **Explain** why the water in the storage reservoir has potential energy that is useful in hydroelectric power generation. **1 point**

Accept one of the following:

- The dam holds water at a higher elevation than the turbine and is allowed to flow downhill toward the turbine.
- Water has potential energy due to gravity allowing water to flow down toward the turbine when released.
- The greater the difference between the dam height (head) and position of the turbine, the more hydrostatic pressure is built up.

(iii) **Explain** how coupling hydroelectric power with solar or wind power is an advantage to providing a constant source of electricity to a community. **1 point**

Accept one of the following:

- Solar and wind power are both intermittent as result of weather changing from day to day (or day to night) so hydroelectric power could be used to provide electricity when the solar or wind power is unavailable/not sufficient for electricity demand.
- Solar or wind power could be used to pump water into a reservoir increasing the amount of water behind the dam to increase hydroelectric power generation.

(iv) **Explain** how a hydroelectric power system, like the one depicted, may be negatively affected by climate change. **1 point**

Accept one of the following:

- Decrease in water storage due to drought, evaporation or reduced rain fall decreases the amount of electricity generated.
- Increased need for irrigation due to drought or reduced rainfall leads to reduction of the amount of water stored in reservoirs, decreasing the amount of electricity generated.
- Increased frequency of extreme precipitation events such as floods or droughts as a result of climate change cause a larger amount of sediments to fill the reservoir, reducing storage capacity and decreasing the amount of electricity generated.
- In the short-term, run-off may increase from loss of glaciers, leading to increased water available for power production, increasing the amount of electricity generated.
- In the long-term, after glaciers melt, there will be decreased run-off, decreasing water storage, decreasing the amount of electricity generated.

Total for part (b) 4 points

(c) (i) **Identify** one advantage, other than the generation of hydroelectric power, of the formation of a reservoir behind a hydroelectric dam. **1 point**

Accept one of the following:

- Increase in aquatic habitat behind the dam/increase in lake species in reservoir
- Provision of recreational facilities
- Increased flood control
- Water storage/drinking water source
- Water for irrigation

(ii) **Explain** the effect of increased silt in the reservoir on the hydroelectric power system. **1 point**

Accept one of the following:

- Silt in reservoirs decreases water storage capacity and can lead to reduced power generation or reduced potential energy.
- Silt in reservoirs decreases water storage capacity and can lead to the release of water over a spillway, rather than using it to generate electricity.
- Silt can damage the turbine and other mechanical equipment by abrasion of blades. Damaged equipment decreases efficiency and/or requires expensive repairs.

Total for part (c) 2 points

Total for question 1 10 points

Question 2: Analyze an Environmental Problem and Propose a Solution

10 points

(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. **1 point**

Accept one of the following:

- Control disease vectors, such as mosquitos, ticks, rats, mice that can spread diseases to humans/between humans.
- Reduce exposure to stinging insects that carry disease.
- Increased food production leads to decreased famine/increased availability of food, improving human health.

Total for part (a) **1 point**

(b) **Identify** one way chemical pesticides can enter the human body. **1 point**

Accept the following:

- Inhalation/Breathing (in aerosols and powders)
- Drinking water contaminated by runoff (from farms, yards, golf courses, etc.)
- Consumption of food (pesticide residue on or in food eaten by consumers)
- Dermal absorption/through skin during application of pesticide

Total for part (b) **1 point**

(c) (i) **Identify** the year when the pesticide was most effective at reducing the size of the pest population. **1 point**

- 1975

(ii) **Describe** the change in the number of crop insect pests in the cotton fields over time. **1 point**

Accept one of the following:

- From 1960 to 2015 the number of pests captures increased from 700 to 1100.
- The number of pests was high before the pesticide was used, then it dropped dramatically after the first application and then increased again over time.
- The number of pests went from 2 captured in 1975 to 1100 captures in 2015.

(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. **1 point**

Accept one of the following:

- Over time the number of pests that are killed decreases (more pests are found in traps), and more pesticide has to be applied (increased grams per hectare) because the pests that are resistant to the pesticide survive and reproduce, passing along resistance to the pesticide.
- The data in the table illustrates the pesticide treadmill, where each year more pesticide has to be applied, and fewer pests die because following the application only pests with resistance to the pesticide survive and reproduce.
- Pesticide effectiveness following the initial application in 1975 decreased over time. Regardless of whether application quantities were constant (1975-1985) or increased (1990-2015), the number of pests captured steadily increased because an increasing number of surviving pests had genetic resistance to the pesticide.

Total for part (c) **3 points**

(d) **Describe** TWO effects of pesticide use, other than death, on nontarget wildlife. **2 points**

Accept two of the following:

- The pesticide may contaminate soil/water having a negative impact on organisms.
- The pesticide may bioaccumulate in the body of the organisms.
- The pesticide may biomagnify in the food web/chain of the organisms.
- There may be an increase in the population of non-target organisms unaffected by the pesticide that will have new areas of habitat available to them.
- There could be a decrease in predator species, so prey species will grow rapidly.
- Endocrine disruption leading to reproductive/development abnormalities.
- Chemicals disrupt signaling/communication in bees.
- Lead to thinning of eggshells/developmental abnormalities in organisms.
- Eliminates food supply; disrupts food chain for other species.

Total for part (d) **2 points**

(e) (i) Crop rotation is often used to reduce pesticide use. **Describe** the process of crop rotation. **1 point**

Accept one of the following:

- The process of growing different crops in succession on the same piece of land.
- The process of growing different crops in the same area during different seasons.
- The process of harvesting one crop followed by the planting of a different crop in the same area.

(ii) **Propose** one reasonable method, other than crop rotation, to reduce the use of pesticides in agricultural practices while still maintaining a high crop yield. **1 point**

Accept one of the following:

- Use integrated pest management to control the insect crop pest.
- Use a method of pest control that employs a variety of biological, physical, and chemical methods to control the insect crop pest.
- Reduce stubble/crop residues in fallow fields that can harbor the insect crop pest.
- Apply the pesticide when the insect crop pest is most susceptible.
- Use intercropping rather than a monoculture to reduce the amount of habitat for the pests.
- Use pest-resistant genetically modified organisms.

(iii) **Justify** how the method proposed in (e)(ii) would provide a benefit to humans. **1 point**

Accept one of the following:

- Reduction in pesticide residue in food/reduction of pesticide ingested by humans.
- Economic benefits to humans including:
  - Less money spent on pesticides
  - Increased profit for farmers from crops
  - Less equipment required/less labor required to spray fields with pesticides
- Reduction in the number of workers exposed to pesticides/Improved health in agricultural workers from reduced pesticide exposure.

Total for part (e) 3 points

Total for question 2 10 points

Question 3: Analyze an Environmental Problem and Propose a Solution

Doing Calculations — 10 points

(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. **1 point**

Accept one of the following:

- Specialists have narrow ecological niches compared to broad niches of generalist species, which are reduced even further by habitat fragmentation.
- Specialists with specialized adaptations are unable to adapt quickly, making them more vulnerable to habitat fragmentation than generalists that adapt quickly.
- Specialists tend to have small populations with less genetic variation than generalist species with larger populations and more genetic variation, making specialists more vulnerable to habitat fragmentation.

(b) **Identify** the symbiotic relationship between the wood thrush and the cowbird. **1 point**

Accept one of the following:

- Parasitism
- Brood Parasitism
- The cowbird uses the wood thrush (as the surrogate parent) to raise their hatchling, which negatively affects the wood thrush and benefits the cowbird.

(c) **Describe** one ecological advantage of leaving areas of undeveloped forest in the development plan as compared to clear-cutting the property. **1 point**

Accept one of the following:

- Since the habitat isn't being clear-cut, it does preserve some biodiversity by allowing some of the species to survive in the fragmented areas of the forest.
- Habitat fragmentation can benefit some generalist species or species which thrive in edge habitat, leading to population increases for those species.
- If planned with buffer zones around targeted conservation areas, edge disturbances for specialist species can be reduced.
- The remaining forest/trees will reduce soil erosion.
- The remaining forest will help with climate/cooling resulting from transpiration/shade from trees.

(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. **1 point**

Accept one of the following:

- Leave areas for wildlife corridors/crossings to prevent isolating populations.
- Include conservation easements in the plan that will preserve species and also provide tax breaks for the residents.
- Create buffer zones near the development to separate it from wildlife habitat.
- Create a mitigation plan that preserves land elsewhere of similar quality.
- Cluster housing or vertical development to limit the development footprint.
- Incorporate common green spaces that promote wood thrush populations.

(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. **1 point**

One point for the correct setup to calculate the area:

- $275 \text{ territories} \times \frac{800 \text{ m}^2}{1 \text{ territory}}$

One point for the correct calculation of the area: **1 point**

- 220,000 m^2

Total for part (e) **2 points**

(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. **1 point**

One point for the correct setup to calculate the number of male wood thrush territories:

- $1{,}000 \text{ lots} \times \frac{1{,}100 \text{ m}^2}{1 \text{ lot}} \times 0.10 \div 800 \text{ m}^2 \text{ per territory}$

One point for the correct calculation of the number of male wood thrush territories, accept one of the following: **1 point**

- 137.5 male wood thrush territories
- 137 male wood thrush territories
- 138 male wood thrush territories

Total for part (f) **2 points**

(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. **1 point**

One point for the correct setup to calculate the percentage of each lot to be set aside:

- $\frac{220{,}000\,\text{m}^2}{1{,}100{,}000\,\text{m}^2} \times 100$
- $275\ \text{territories} \times \frac{110{,}000\,\text{m}^2}{137.5\ \text{territories}} \div 1{,}100{,}000\,\text{m}^2 \times 100$
- $\frac{275\ \text{territories} \times 10\%}{137.5\ \text{territories}} \times 100$

One point for the correct calculation of the percentage of each lot to be set aside: **1 point**

- 20% of each lot

Total for part (g) 2 points

Total for question 3 10 points