

**AP[®] ENVIRONMENTAL SCIENCE
2012 SCORING GUIDELINES**

Question 3

The active ingredients in many pesticides are chemical compounds that kill organisms such as insects, molds, and weeds. Proponents claim that the use of pesticides improves crop yields and thus protects land and soil by reducing the conversion of forests and wetlands to cropland. Opponents of pesticide use claim that pesticides degrade water and soil quality and that other modern agricultural techniques and practices are responsible for the improved crop yields in recent years.

(a) Design a laboratory experiment to determine whether or not a new pesticide (product X) is toxic to minnows, a type of small fish. For the experiment you design, be sure to do all of the following.

(i) State the hypothesis.

(1 point)

A correct hypothesis includes the following:

- The hypothesis must predict a relationship between product X and minnow health.
- The prediction must indicate a specific direction of change for each variable, such as:
 - An increase in product X concentration will result in increased minnow mortality.
 - Does decreasing exposure to product X result in increased survivorship of minnows?
- Students may also state a null hypothesis in which they predict no relationship between product X and minnow health, such as:
 - Changing the concentration of product X has no effect on minnow health.
 - Increasing exposure to product X does not change minnow mortality.

(ii) Describe the method you would use to test your hypothesis.

(1 point)

A point is earned for a correct method that indicates the manipulation of the independent variable (product X). *Note:* The method must include a minimum of three experimental groups, one of which is not exposed to product X.

(iii) Identify the control.

(1 point)

A point is earned for the identification of an experimental group without the presence of product X as the control.

(iv) Identify the dependent variable.

(1 point)

A point is earned for the identification of a measure of minnow health as the dependent variable.

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Question 3 (continued)

- (b) Describe experimental results that would lead you to reject your hypothesis in part (a)(i). (Be specific.)**
(1 point)

A point is earned for a correct description of experimental results that include minnow health measurements that contradict the prediction in the hypothesis stated in part (a)(i). *Note:* A point can be earned with an incorrectly stated hypothesis in (a)(i), if the results described correctly contradict the statement in (a)(i).

- (c) One strategy for dealing with agricultural pests is integrated pest management (IPM).**

- (i) Describe IPM. As part of your description, include TWO specific pest-control approaches that are part of IPM.**

(3 points: 1 point for a description of IPM and 1 point each for including two specific pest-control approaches that are part of IPM)

One point can be earned for a description of IPM that demonstrates an understanding of one of the following:

- IPM uses a combination of biological, chemical, and physical (two of the three) means to control pests.
- IPM is used to reduce or eliminate the use of pesticides.
- IPM is used to reduce pest populations to acceptable or tolerable levels.

One point can be earned for each of two specific pest-control approaches that are part of IPM (only the first two approaches mentioned can earn points):

- Introduce, attract, or create habitat for the predators of pests.
- Introduce parasites that feed on pests.
- Introduce diseases or disease-carrying bacteria to kill pests.
- Vacuum pests from crops.
- Rotate crops.
- Plant multiple crops simultaneously (e.g., polyculture, intercropping).
- Adjust the planting times of crops.
- Use pheromones to attract pests to traps.
- Spray crops with hot water to scald pests.
- Introduce sterile males into pest populations to decrease their reproductive success.
- Use narrow-spectrum, or less persistent pesticides.
- Spray crops with soap solutions.
- Use noise to repel pests.
- Cultivate pest-resistant genetically modified crops.
- Use physical barriers to prevent pests from reaching crops.
- Other appropriate examples may also earn points.

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Question 3 (continued)

(ii) Identify one environmental benefit of using IPM.

(1 point: only the first benefit mentioned can earn a point)

Note: The benefit must be environmental; economic and societal benefits are not acceptable:

- Reduces the introduction of pesticides into areas other than farmland (e.g., runoff, overspray).
- Reduces incidental killing of non-targeted organisms (e.g., bees, spiders, ladybugs, birds).
- Reduces soil compaction by pesticide application equipment.
- Reduces CO₂ emissions from pesticide production and application equipment.
- Reduces erosion.
- Reduces bioaccumulation/biomagnification of pesticides.
- Reduces genetic resistance to pesticides.
- Other appropriate examples may also earn points.

(d) Describe TWO agricultural practices, other than those involving pest control, that increase crop yields.

(2 points: 1 point for each correct practice described; only the first two practices mentioned can earn points)

The following are acceptable with a suitable description of the practice or how the results of the practice would increase crop yields:

- Develop and plant high-yielding varieties of crops.
- Plant high-yielding genetically modified varieties of crops.
- Plant monocultures (monocropping).
- Plant polycultures.
- Rotate crops.
- Intercropping (alley cropping).
- Use irrigation systems.
- Apply fertilizers.
- Amend soil with organic material (e.g., compost, manure, mulch).
- Keep land in constant production (multiple cropping).
- Use modern farm equipment (e.g., tractors, harvesters).
- Grow crops in greenhouses.
- Grow crops hydroponically.
- Terracing of slopes.
- Contour plowing.
- Plant windbreaks or shelterbelts.
- Plow or till soil.
- Till soil with lower frequency (low-till or no-till).
- Slash and burn farming practices.
- Plant cover crops.
- Other appropriate examples may also earn points.

3. The active ingredients in many pesticides are chemical compounds that kill organisms such as insects, molds, and weeds. Proponents claim that the use of pesticides improves crop yields and thus protects land and soil by reducing the conversion of forests and wetlands to cropland. Opponents of pesticide use claim that pesticides degrade water and soil quality and that other modern agricultural techniques and practices are responsible for the improved crop yields in recent years.
- (a) Design a laboratory experiment to determine whether or not a new pesticide (product X) is toxic to minnows, a type of small fish. For the experiment you design, be sure to do all of the following.
 - (i) State the hypothesis.
 - (ii) Describe the method you would use to test your hypothesis.
 - (iii) Identify the control.
 - (iv) Identify the dependent variable.
 - (b) Describe experimental results that would lead you to reject your hypothesis in part (a)(i). (Be specific.)
 - (c) One strategy for dealing with agricultural pests is integrated pest management (IPM).
 - (i) Describe IPM. As part of your description, include TWO specific pest-control approaches that are part of IPM.
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Hypothesis: Higher concentrations of the new pesticide (product X) will result in ~~higher mortality~~ more mortalities in a given population of minnows

Method: Four separate freshwater tanks will each contain 20 minnows. Tank 1 is the control and contains no pesticide. Tank 2 will have a ~~0.05%~~ .05% concentration of pesticide, tank 3 will have a .1% concentration of pesticide and tank 4 will have a .2% concentration of pesticide. After each day of exposure, the number of ~~minnow~~ minnows dead will be counted and recorded. ~~with~~ Exposure should last ~~and~~ for 30 days. The dependent variable is the number of dead minnows for each tank each day. I would reject my hypothesis if the tank with the most pesticide had the least number of minnow deaths

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or if the control tank (tank 1) had the most deaths. This would lead me to believe that the pesticide helped prevent the minnows from dying.

Integrated pest management (IPM) is a pest-control approach that prevents using ~~the~~ dangerous pesticides and other destructive methods. IPM includes methods such as introducing ~~harmless~~ pest predators that are harmless to the crops being protected. Another method ~~is using~~ ~~organic, harmless, chemicals that prevents pests from~~ is changing the crop from year to year to kill off populations of crop-specific pests. For example, if a pest only eats corn, then a farmer can plant soy beans one year. Without the corn crop, the ~~pests with~~ pest population will die off or shrink dramatically. One environmental benefit of using IPM is that it prevents hazardous chemicals like pesticides from entering streams, rivers, and other water sources. In other words, the surface runoff from farms will not contain so many chemicals.

~~Then~~ Using fertilizer is one way to increase crop yields because it provides the nutrients the crops need to grow to their full potential. Rotating crops can also increase yields because it prevents the soil from losing certain nutrients. Planting the same crop in the same location every year exhausts the soil of specific nutrients.

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A) i) If product X is put in a ~~pond~~^{tank} containing minnows, then the minnows will not be able to survive.

ii) Fill three separate tanks with pondwater containing a certain species of minnow. Be sure that all water and all minnows were retrieved from the same place. Make sure that all tanks are kept at the same temperature, and that each tank receives the same amount of exposure to the sun. ~~In tank one, add~~ Also, each tank should contain exactly 50 ^{liters} ~~gallons~~ of water. ^{and 100 minnows} In tank one, place ~~no~~ 0 ^{liters} ~~gallons~~ of product X. In tank two, place one liter of product X. In tank three, place two liters of product X. Record the number of dead minnows.

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in each tank every ten hours for one week.

iii) The control in this experiment is tank 1.

iv) The dependent variable is the number of deceased minnows.

B) I would reject my hypothesis if more minnows died in tank one than in tank two and tank three.

C) i) Integrated Pest Management (IPM) is a strategy for dealing with agricultural pests in which ~~a new species of animal is introduced that~~ several approaches are taken to combat the problem. For example, a farm dealing with locusts may introduce a species of bird that will help control the population of locusts. In addition, the farmer may use pesticides on a separate area.

ii) One benefit of IPM is that because pesticides are only used on parts of the farm, the pest will not develop immunity to the pesticide.

D) One agricultural practice that increases crop yields is crop rotation, which is when a farmer rotates which

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crops are planted in a certain location. For example, a farmer may grow corn in one area, but the next year, he/she will plant wheat. This allows the soil to regain nutrients that may have been lost while the corn was growing that the wheat doesn't require. Another agricultural practice is terracing, which allows farmers to plant on steep hills. This practice also improves irrigation. If the farmer waters starting at the top of the slope, the excess water will naturally flow downward, onto the next terrace, thus reducing the amount of wasted water.

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ai) If the minnow is affected by the active ingredient in product X, then it will get sick or die.

ii) I would put the same number of minnows into 4 different fish tanks. I would also put the same amount of water in each fish tank. Then, I would keep the first fish tank free of all pesticides and vary the concentration of the pesticide in the remaining fish tanks (concentration ranging from small to large amounts). I would then observe the effects of the pesticide on the fish for a predetermined amount of time the same ^{for all tanks}.

iii) The control would be the first fish tank in which normal minnow behavior is observed.

iv) The dependent variable is concentration of pesticide in the water.

b) In all of the tanks that had concentrations of the pesticide the fish all acted normally, seemed like the fish in the

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first tank without any pesticides in it. Even the ^{fish in the} tank that had the highest concentration of pesticides showed no effects.

c) i) Integrated pest management is an approach to ~~controlling~~ controlling pests in a sustainable, environmentally friendly way. There is a cultural control in which the life style of the pest is learnt and the pest is eradicated by using methods that will alter the lifestyle. Another method is through ~~bringing in~~ ^{natural} pest control which involves the bringing in of natural predators to the pests to subdue them.

ii) It does not rely heavily on pesticide use so there will be little instances of altering the biogeochemical cycles or causing excess nutrients in bodies of water that will lead to eutrophication.

d) One method of increasing crop yields is to implement the practice of crop rotation. This method keeps the soil healthy and nutrient filled to get the highest yields. Another method of increasing yields is to use compost to naturally give nutrients back to the soil and to keep weeds away.

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2012 SCORING COMMENTARY

Question 3

Overview

The intent of this question was to have students demonstrate their ability to design a controlled experiment and to demonstrate their knowledge of integrated pest management (IPM) and agricultural practices that increase crop yields.

Sample: 3A

Score: 10

Four points were earned in part (a): 1 point in part (i) for a correct hypothesis, 1 point in part (ii) for correctly indicating the manipulation of the independent variable, 1 point in part (iii) for correctly identifying the control, and 1 point in part (iv) for correctly identifying the dependent variable as “the number of dead minnows.” One point was earned in part (b) for describing results that indicate the opposite of the prediction in the stated hypothesis. Three points were earned in part (c): 2 points in part (i) for identifying two specific pest-control strategies that are part of IPM (“introducing pest predators” and crop rotation) and 1 point in part (ii) for identifying the prevention of pesticide runoff into streams as an environmental benefit of IPM. Two points were earned in part (d): 1 point for describing the use of fertilizers to provide nutrients for crops and 1 point for describing crop rotation.

Sample: 3B

Score: 8

Three points were earned in part (a): 1 point in part (ii) for correctly indicating the manipulation of the independent variable, 1 point in part (iii) for correctly identifying the control, and 1 point in part (iv) for correctly identifying the dependent variable as “the number of deceased minnows.” One point was earned in part b for describing results that indicate more minnow deaths in the control group than in the presence of product X. Two points were earned in part (c): 1 point in part (i) for including the pest-control approach of introducing birds to kill locusts and 1 point for identifying the reduced immunity to pesticides as an environmental benefit of IPM. Two points were earned in part (d): 1 point for a correct description of crop rotation and 1 point for a correct description of the terracing of steep hills.

Sample: 3C

Score: 6

Two points were earned in part (a): 1 point in part (ii) for correctly indicating the manipulation of the independent variable and 1 point in part (iii) for correctly identifying the control. One point was earned in part (b) for describing results that indicate that there is no effect on any of the minnows. One point was earned in part (c)(i) for including the pest-control approach of bringing in the natural predators of pests. Two points were earned in part (d): 1 point for describing crop rotation as a method that “keeps the soil healthy” and 1 point for describing the use of “compost to ... give nutrients back to the soil.”