AP® ENVIRONMENTAL SCIENCE
2014 SCORING GUIDELINES

Question 1

(a) State whether you agree or disagree with each of the following remarks made by Dr. Kull. For each remark, provide one justification for your position.

(i) "Nuclear power plants produce no dangerous solid waste."
(1 point can be earned for disagreeing along with one of the following justifications)

- Radioactive wastes are produced (must be stored for long periods of time)
- Spent fuel rods are radioactive
- Clothing, gloves, tools are radioactive
- Radioactive waste results from accidents

(Note: No point can be earned if the student states that they agree with the argument.)

(ii) "Using nuclear power plants avoids the release of greenhouse gases."
(1 point can be earned for a correct justification of the stated position)

Position	Justification
Agree	• Fossil fuels are not combusted • The normal operation involves no combustion
Disagree	• GHGs are released when fossil fuels are used during the mining, transportation, enrichment processes of fuel, construction, and decommissioning of nuclear power plants • Water vapor is released

(b) If the plan for a nuclear power plant in Fremont is approved, it will take several years for the plant to be built. Describe TWO environmental problems that could result from the construction of the plant (i.e., prior to operation).
(2 points: 1 point for each correct description. Only the first two descriptions can earn a point)

- Habitat or riparian area destruction/fragmentation at the construction site
- Disruption of habitat caused by the installation of power lines
- Water pollution/stormwater runoff
- Soil compaction from the construction process or by machinery use
- Sediment runoff/erosion in wet weather
- Noise pollution from machinery
- Construction waste disposal/landfill
- Gases/pollution emitted from machinery such as CO_2, NO_2, SO_2, CO, PM

(Note: Only problems relating to the construction of the power plant can earn a point.)

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Question 1 (continued)

(c) Suppose that the nuclear power plant is constructed on the Fremont River site.

(i) Identify the most likely pollution threat that the plant will pose to the Fremont River as a result of the plant's normal daily operation.
(1 point can be earned for correctly identifying thermal pollution as the most likely pollution threat. Release of radioactive wastes is NOT part of the normal operation of a nuclear power plant)

(ii) Discuss one potential ecological consequence of the pollution threat that you identified in part (i).
(1 point can be earned for discussing an ecological consequence of thermal pollution)

- Decline in dissolved oxygen (DO)
- Impacts on biodiversity
- Thermal shock in organisms
- Increased rates of metabolism in organisms
- Increased bacterial growth
- Increased incidence of disease in fish
- Increased algal growth

(iii) Identify a system often used in nuclear power plants to reduce the pollution you identified in part (i).
(1 point can be earned for identifying an acceptable system)

- Cooling towers
- Cooling ponds and canals
- Longer discharge pipes (increase the distance between the power plant and the discharge point)

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Question 1 (continued)

(d) Describe TWO specific steps that Fremont residents and/or businesses could take to reduce the use of electricity.
(2 points: 1 point for each correct description of a valid step to reduce *the amount of electricity being used in Fremont)*

- Replace existing appliances with more efficient appliances (e.g., air conditioners, heat pumps, refrigerators, stoves, hot water heaters)
- Replace electrical appliances with gas appliances (e.g., stove, hot water heater)
- Switch to passive solar heating or cooling techniques
- Replace incandescent light bulbs with CFLs or LEDs
- Replace a conventional water heater with a tankless hot water heater
- Increase insulation (e.g., walls, ceiling, hot water heater)
- Turn thermostats down in the winter or up in the summer
- Turn off electrical appliances when not in use
- Unplug chargers
- Develop a series of public service announcements (PSAs) to educate the public about how to reduce electrical consumption
- Other appropriate techniques

(Note: points earned for reducing electrical use, not for replacing the source of the electrical power.)

(e) Identify a specific nuclear power plant at which a major accident has occurred. Explain one environmental consequence (other than effects on human health) of a nuclear power plant accident.
(2 points: 1 point for identifying a plant where a major accident has occurred and 1 point for explaining an environmental consequence of a nuclear accident)

The following are acceptable nuclear power plant accident sites:
- Three Mile Island
- Chernobyl
- Fukushima Daiichi

Correct explanations of environmental consequences due to radiation leaks include the following:
- Cancer/tumors in animals
- Radioactive contamination of plants or animals in food webs
- Genetic mutations
- Death of plants or animals
- Impacts on biodiversity
- Impacts on plant or animal population size

(Note: The explanation **does not** have to be linked to the specific accident; however, if the explanation is linked, it must be correct.)

PAGE FOR ANSWERING QUESTION 1

a) (i) I disagree with this statement because nuclear power produces highly radioactive waste. This waste is very dangerous, it can cause cancer and death in humans.

(ii) Yes, Nuclear power does release greenhouse gases. So I disagree with this statement too. During the cooling process, of the production of nuclear power, water vapor is released from the cooling towers. Water vapor is a natural greenhouse gas, but it still causes the Earth to warm.

b) 1. One environmental impact would be the distruction of habitat for organisms because of the removal of trees to make room for the nuclear power plant.

2. During the construction phase if a silt fence is not put up or not properly installed sediment can move into streams causeing loss in trubinty or lack of sunlight ~~made~~ entering the water, is another environmental impact. The disturbance of the soil is caused by construction then if it rains that soil would run off if there is no silt fence installed.

C) (i) Thermal pollution would be the threat from day to day operation. (ii) If the ~~cooling tower water~~ warm water from the nuclear plant is being discharged into the river it can shock the fish which could kill them or cause the dissolved →

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O_2 levels to drop because warm water doesn't hold O_2 as well as cool water does.

(iii) Cooling towers, store the warm water untill it cools enough to be let out back in to the river, so it does not cause thermal pollution

d) 1. Fremont's citizens can shut off lights when they leave a room which would decrease their electricity demand.

2. Fremont's citizens can also turn their electric thermostat down so the heat doesn't turn on when they don't need the heat. This would also lessen the demand on electricity

e) Fukashema, Japan. The water that was pumped to cool down the reactors have now been contaimated with radioactive isotopes, so there is less avaible water for human or anyother organisms to use without getting sick. The ocean fish have been contaminated too which can cause a food shortage for humans or other animals.

(a)(i) I disagree that nuclear plants produce no dangerous solid waste because they actually produce hazardous waste in the form of nuclear reactor cores that take very long time periods to become safe due to the threat of radiation. An example would be uranium 235 cores that must be stored at power plants or underground.

(ii) I agree that nuclear power avoids the release of greenhouse gases because it generates power by superheating water to steam to drive a turbine and therefore no fossil fuels or other substances are burned to produce greenhouse gas emissions.

(b) One environmental problem will be the runoff from the construction site into the river it is being built on. Another problem would be the clearing of land and destruction of habitat to provide the area to build the power plant on which would disrupt the ecosystem and possibly lower biodiversity.

(c)(i) The most likely pollution threat would be thermal pollution, the highly heated water, from the daily operation.

(ii) One potential ecological consequence would be a drop in dissolved oxygen in the river due to the hot water from the plant which would make it difficult for some species to survive.

(iii) Power plants often install cooling systems so that the water they discharge back into the river is not as hot. This process also may include aerating the water to increase

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

the dissolved oxygen content.

(d) Fremont residents and businesses could switch to LED light bulbs instead of incandescents as well as install more efficient appliances such as energy star appliances.

(e) Chernobyl was a nuclear accident that occured in the former Soviet Union. This nuclear accident caused massive amounts of radiation to enter the surrounding environment which resulted in animal and plant death as well as alterations in DNA that caused future mutations in those animals. It in essence created a dead zone.

a)i) I disagree with Pamela Kull on the idea that Nuclear power plants create/produce no dangerous solid waste. Her remark was completely false because through the process of creating nuclear energy, spent fuel rods remain which are very radioactive and take thousands of years to become safe. Most times, the fuel rods are made of uranium, a radioactive element.

ii) I disagree with Ms. Kulls remark that no green house gasses are emmitted. Even though no harmfull gases are emmitted, water vapour is emmitted. Through research, scientists have discovered that the largest and most abundant green-house gas in the atmosphere is watervapour.

b) The construction of the power plant could cause two major environmental problems. First, animal habitat and forestry may be destroyed, causing a migration or movement of animals and organisms to an unfamiliar area. Secondly, through the construction of the plant, machinery would be used to construct building, commute to the work cite, etc. These machines would then use up resources such as gasoline and release harmfull emisions like Carbon dioxide and other green house gasses.

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

c.) i) As a result of the daily operation of the plant, radioactive material, such as spent fuel rods and uranium, may leak into the groundwater and Fremont river. This could eventualy cause abnormalities in the organisms of the river such as fish, vegetation, turtles, etc.

ii) The pollution from the plant could cause abnormalities and mutations in the organisms of the river such as fish, vegetation, turtles, etc.

iii) Most times, to prevent leakage, radioactive material is stored in concrete tanks with many unpenetrable layers.

d.) To reduce the use of electricity, Fremont residents could buy energy star appliances which are more efficient for cooking, cleaning, etc. The residents could also replace regular incandescent ligh bulbs with LED light bulbs and turn off unused lights.

e.) A major accident that occured at a nuclear powerplant occured in Fukishima, Japan. In this accident, a tidal wave struck Japan, causing a meltdown at the power plant. A major consequence of this occurance was the leakage of radioactive waste into the surrounding areas. This caused a die off of many organisms in

1C3

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

both the marine surroundings and on land surroundings.

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AP® ENVIRONMENTAL SCIENCE
2014 SCORING COMMENTARY

Question 1

Overview

This intent of this question was to have students demonstrate knowledge of the potential impact of nuclear power plants on the environment. Students were asked to defend or refute statements as to whether nuclear power plants produce no dangerous solid wastes and as to whether they produce greenhouse gases. Students were asked to describe two environmental problems that could result from building a nuclear power plant adjacent to a river. Additionally, students were asked to identify the most likely pollution threat, to the river, from normal daily operation of the plant, discuss an ecological consequence of that threat, and identify a system that is used to reduce that pollution threat. Students were asked to describe two specific steps that could be taken to reduce the use of electricity. Finally, students were asked to identify a nuclear power plant that had a major accident and explain an environmental consequence of an accident at a nuclear power plant.

Sample: 1A
Score: 10

Two points were earned in part (a): 1 point in (i) for disagreeing by saying "nuclear power produces highly radioactive waste" and 1 point in (ii) for disagreeing that nuclear power plants do not release greenhouse gases by stating "water vapor is released from the cooling towers. Water vapor is a natural greenhouse gas." Two points were earned in part (b) for describing that "distruction [*sic*] of habitat for organisms because of the removal of trees" and "sediment can move into streams … lack of sunlight entering the water" as two environmental problems associated with building the nuclear power plant. Three points were earned in part (c): 1 point in (i) for identifying "thermal pollution" as the most likely pollution threat to the river; 1 point in (ii) for discussing that the warmer water "can shock fish or kill them" as an ecological consequence of thermal pollution; and 1 point in (iii) for identifying "Cooling towers" as a system used to reduce thermal pollution. Two points were earned in part (d): 1 point for describing that citizens could "shut off lights" and 1 point for describing that citizens could "turn their electric thermostat down so the heat doesn't turn on" as steps to reduce electrical consumption. One point was earned in part (e) for identifying "Fukashema [*sic*]" as a nuclear power plant where a major accident has occurred.

Sample: 1B
Score: 8

Two points were earned in part (a): 1 point in (i) for disagreeing by saying "hazardous waste in the form of nuclear reactor cores that take very long time periods to become safe" and 1 point in (ii) for agreeing that nuclear power plants do not release greenhouse gases by stating "no fossil fuels or other substances are burned to produce greenhouse gas emissions." One point was earned in part (b) for describing that "clearing of land and destruction of habitat" is an environmental problem associated with building the nuclear power plant. Two points were earned in part (c): 1 point in (i) for identifying "thermal pollution" as the most likely pollution threat to the river and 1 point in (ii) for discussing "a drop in dissolved oxygen in the river due to the hot water" as an ecological consequence of thermal pollution. No points were earned in part (iii). One point was earned in part (d) for describing that "residents and businesses could switch to LED light bulbs instead of incandescents" as a step to reduce electrical consumption. Two points were earned in part (e): 1 point in part (e) for identifying "Chernobyl" as a nuclear power plant where a major accident has occurred and 1 point for describing "animal and plant death" as an environmental consequence of the accident at Chernobyl.

Question 1 (continued)

Sample: 1C
Score: 6

Two points were earned in part (a): 1 point in (i) for disagreeing by saying "spent fuel rods remain which are very radioactive and take thousands of years to become safe" and 1 point in (ii) for disagreeing that nuclear power plants do not release greenhouse gases by stating "water vapour is emmitted [*sic*]." Two points were earned in part (b): 1 point for describing "First, animal habitat and forestry may be destroyed, causing a migration or movement of animals" and 1 point for describing that many construction vehicles would use gasoline "and release harmfull emisions [*sic*] like Carbon dioxide and other greenhouse gases" as two environmental problems associated with building the nuclear power plant. No points were earned in part (c). One point was earned in part (d) for describing that residents could also "replace regular incandescent ligh [*sic*] bulbs with LED light bulbs" as a step to reduce electrical consumption. One point was earned in part (e) for identifying "Fukishima [*sic*]" as a nuclear power plant where a major accident has occurred.