ENVIRONMENTAL SCIENCE
SECTION II
Time—90 minutes
4 Questions

Directions: Answer all four questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers on the pages following the questions in this book. 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.

1. Read the article below and answer the questions that follow.

The Fremont Plaindealer **May 1, 2013**

Last night the county council discussed a motion to support the construction of a new nuclear power plant on the Fremont River to address the rising demand for electrical power in Fremont County. Councilperson Pamela Kull spoke in support of the plant, remarking that "nuclear power plants produce no dangerous solid waste" and "using nuclear power avoids the release of greenhouse gases."

Councilperson Chinh Serach said that Dr. Kull's remarks were incorrect and then introduced a different motion to provide funding to help Fremont homeowners and businesses reduce electricity use. He stated that such steps could make building the nuclear plant unnecessary.

(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."

(ii) "Using nuclear power avoids the release of greenhouse gases."

(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).

(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.

(ii) **Discuss** one potential ecological consequence of the pollution threat that you identified in part (i).

(iii) **Identify** a system often used in nuclear power plants to reduce the pollution you identified in part (i).

(d) **Describe** TWO specific steps that Fremont residents and/or businesses could take to reduce the use of electricity.

(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. Like many communities, Fremont has a combined sewer system that collects both sewage and storm water. When storm water runs into storm drains that connect to the city's sanitary sewer system, the storm water and sewage flow together to the Fremont Wastewater Treatment Plant (FWTP). During a major storm event, however, the combined volume of storm water and sewage may exceed the plant's capacity, and the overflow bypasses the FWTP. The untreated overflow is discharged into Fremont Creek along with the treated waste.

   Recently parts of Fremont received 5 cm of rain in 60 minutes. The storm caused widespread flooding in the northeast section of town. Especially hard hit was the Shoppes at Fremont shopping center.

   Use the data from the table below to answer the questions that follow. Show all calculations.

Fremont Water Data
The shopping center's parking lot is 200 meters long and 100 meters wide.
Fremont has an area of 10 km^2.
Impervious surfaces cover 20 percent of Fremont's area.
The FWTP typically treats 5,000 m^3 of domestic sewage per day.
The FWTP has the capacity to treat 10,000 m^3 of combined sewage and storm water per day.

   (a) **Identify** TWO specific pollutants in storm-water runoff that degrade the quality of surface water.

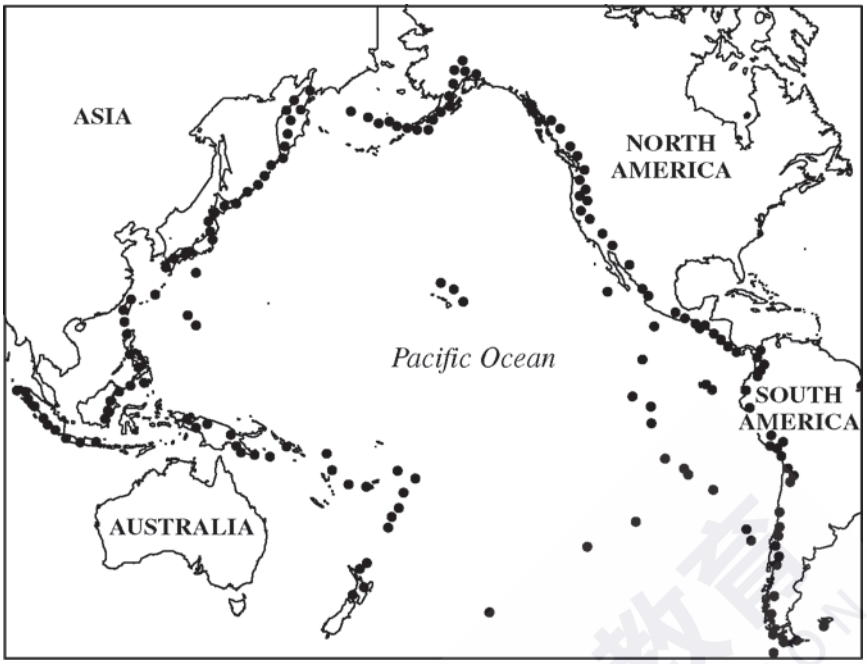
   (b) **Calculate** the volume of water (in m^3) that runs off the Shoppes at Fremont parking lot after a 5 cm rainfall event. Assume that all the water that falls on the parking lot runs off.

   (c) **Calculate** the volume of storm-water runoff (in m^3) generated in all of Fremont by the 5 cm rainfall event. Assume that only the impervious surfaces generate runoff.

   (d) Assume that all the runoff that you calculated in part (c) is captured by the storm sewers in one day. **Calculate** the volume of untreated water (in m^3) that bypasses the plant as a result of the storm. (Note that the plant still receives 5,000 m^3 of domestic sewage per day.)

   (e) **Describe** TWO ways that the volume of storm-water runoff can be reduced.

   (f) **Describe** one environmental problem (other than pollution from runoff and from untreated sewage) that results from having extensive paved areas.



3. Plate-tectonic theory states that the Earth's lithosphere is broken into very slowly moving pieces or plates. Plate movements over vast stretches of time have led to the current orientation of our continents and oceans. Individual events along plate boundaries, such as earthquakes and volcanic eruptions, pose periodic threats to human activity and ecosystems. The "Ring of Fire" is a term that describes the location of increased seismic and volcanic activity around the margins of the Pacific Ocean basin. On the map above, each dot represents a volcano or an earthquake.

   (a) Japan, Indonesia, and the Philippines are examples of volcanic island chains that have formed along subduction zones between plates in the western Pacific.

      (i) **Describe** what happens when two tectonic plates collide along a subduction zone.

      (ii) **Explain** how subduction leads to volcanic activity.

   (b) Although the landscape following a volcanic eruption may appear unable to support ecological communities, over time the area can be transformed through succession.

      (i) What is primary succession?

      (ii) **Explain** how primary succession can lead to soil formation on a newly formed volcanic landscape.

   (c) In addition to volcanic activity, highly destructive tsunamis are generated along Pacific Plate subduction zones.

      (i) **Explain** how a tsunami is generated along a subduction zone.

      (ii) **Describe** one negative ecological impact that tsunamis have on coastal environments.

   (d) Southern California experiences periodic devastating earthquakes along the San Andreas Fault, which is a transform boundary located along the eastern edge of the Pacific Plate.

      (i) **Describe** what happens to the tectonic plates along a transform boundary at the moment when an earthquake occurs.

      (ii) **Describe** what happens to the tectonic plates along a transform boundary during the time <u>between</u> earthquakes.

4. Biogeochemical cycles describe the movement of certain elements (typically bound with other elements in compounds) through Earth's atmosphere, hydrosphere, biosphere, and lithosphere. These elements and their compounds are necessary components of all life, and because they cycle, they can be used repeatedly by new generations of organisms. Each biogeochemical cycle has different pathways with various reservoirs (sources and sinks) where elements may reside for days or millions of years.

   (a) The atmosphere is one important carbon reservoir.

      (i) **Describe** a biological process by which carbon is removed from the atmosphere and converted to organic molecules.

      (ii) **Describe** a biological process by which carbon is converted from organic molecules to a gas and returned to the atmosphere.

   (b) Oceans and terrestrial systems are also important carbon reservoirs.

      (i) **Explain** how atmospheric carbon is incorporated into two oceanic sinks.

      (ii) **Identify** one terrestrial sink, other than fossil fuels, that stores carbon for thousands to millions of years.

   (c) The burning of fossil fuels has been shown to increase the concentration of carbon in the atmosphere. **Discuss** TWO other human activities that increase the concentration of carbon in the atmosphere.

   (d) **Identify** an environmental problem that results from elevated atmospheric carbon concentrations. **Discuss** one consequence of the problem you identified.

   (e) Phosphorus is another element important to all organisms.

      (i) **Describe** one major way in which the phosphorus cycle differs from the carbon cycle.

      (ii) **Identify** one reason that phosphorus is necessary for organisms.

STOP

END OF EXAM