

AP Environmental Science

Midterm Examination Section II

The following four free response questions will count toward 40% of your midterm examination grade. They will be collected on the date of the midterm (January 25th). Failure to hand in the free response questions during the midterm will result in a zero for this portion of the midterm. Papers suspected of cheating and/or copying will result in an automatic zero on the entire midterm examination.

Directions: Answer all four questions, which are weighted equally. Write all answers on a separate piece of paper. 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. A family is building a new home in Buffalo, New York. Buffalo experiences severe winters. Assume the following.
 - The house has 4,000 square feet.
 - 100,000 Btus of heat per square foot are required to heat the house for the winter.
 - Natural gas sells for \$5.00 per thousand cubic feet.
 - 1 cubic foot of natural gas supplies 1,000 Btus of heat energy.
 - 1 kilowatt-hour of electricity supplies 10,000 Btus of heat energy.
 - Electricity costs \$50 per 500 kWh.
 - a. Calculate the following, showing all the steps of your calculations, including units.
 - i. The number of cubic feet of natural gas required to heat the house for the winter.
 - ii. The cost of heating the house using natural gas.
 - iii. The cost of heating the house using electricity.
 - b. The homeowners are discussing with their architect the possibility of using either active or passive solar design to reduce their heating and/or cooling costs. Compare these two techniques.
 - c. The homeowners wish to incorporate green design. Discuss five techniques that the homeowners could adopt to make their home green. (Green does not refer to the color of the house!)

2. The environmental impact of washing a load of clothes in an electric washing machine is different than washing the same clothes by hand. Use the information below to answer the questions that follow. Show your calculations.

Assume the following:

1. All of the clothes can be washed in one load in the washing machine.
2. The water entering the water heater is 60°F.
3. The water leaving the water heater is 130°F.
4. The electric washing machine uses 20 gallons of water. It uses 110 volts of electricity at an average of 1,500 watts for 30 minutes.
5. Washing the clothes by hand requires 35 gallons of hot water.

Other information:

1 gallon of water = 8 pounds

1 Btu = amount of energy required to raise the temperature of 1 pound of water by 1°F

1 kilowatt-hour = 3,400 Btus

- a. Calculate the total amount of energy (in Btus) to wash the clothes using the washing machine.
- b. Calculate the total amount of energy (in Btus) to wash the clothes by hand.
- c. Discuss the environmental impact of washing clothes.

3. Radioactive isotopes are widely used in the field of medicine, in the generation of electricity, and in the military. The use of radioactive isotopes has increased significantly over the past fifty years, leading to a corresponding increase in the amount of radioactive waste produced. The question of how to deal with radioactive waste is a topic of ongoing environmental concern.
 - a. Explain how the properties of low-level radioactive waste differ from those of high-level radioactive waste and how these properties lead to different storage requirements. For one of the two types of radioactive waste, give an example of a specific isotope that may be present in the waste, and explain how human activity generates the waste.
 - b. The United State Department of Energy recently chose Yucca Mountain in Nevada as the site for the deep underground burial of high-level radioactive waste. Describe THREE characteristics of an ideal deep underground storage site for high-level radioactive waste.
 - c. Identify TWO other options that have been suggested for the long-term management of radioactive waste. Discuss the feasibility of each method.
 - d. Exposure to high levels of ionizing radiation has adverse effects on human health and can result in immediate death. Identify one sublethal adverse effect on human health that can result from exposure to ionizing radiation, and explain how this effect is caused by the radiation.

4. Read the *Fremont Examiner* article below and answer the questions that follow.

10	FREMONT EXAMINER	May 15, 2007
<h2 style="margin: 0;">CITY COUNCIL SEWAGE VOTE</h2>		
<p>Last night the Fremont City Council, by a 4-to-1 vote, approved an upgrade of the town's sewage treatment facility. The treatment plant, which currently discharges one million gallons of treated wastewater into the Fremont River daily, will be upgraded from primary to secondary treatment next year. Councilperson</p>	<p>Ramos noted that the upgrade was needed to protect the water quality of the Fremont River. A local environmental scientist, Dr. Goodwin, advised the council members that sewage treatment plants may solve a water quality problem, but they create a solid-waste problem.</p>	

- a. Identify ONE component of the sewage that is targeted for removal by primary treatment and ONE component of the sewage that is targeted for removal by secondary treatment.
- b. For EACH of the pollutants that you identified in part (a), describe how the pollutant is removed in the treatment process.
- c. Explain how sewage treatment plants create the solid waste problem that Dr. Goodwin mentioned in the article.
- d. Two common methods of disposing of solid waste from sewage treatment plants are transporting it to a landfill or spreading it onto agricultural lands. Describe an environmental problem associated with EACH of these methods.
- e. The final step in sewage treatment is disinfection. Identify ONE pollutant that is targeted during disinfection and identify ONE commonly used method of disinfection.
- f. Identify ONE United States federal law that requires monitoring the quality of the treated sewage that is discharged into the Fremont River.