



## AP<sup>®</sup> Environmental Science 2001 Sample Student Responses

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# ENVIRONMENTAL SCIENCE

## SECTION II

Time—90 minutes

NO CALCULATORS MAY BE USED ON THIS EXAMINATION

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 booklet. 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. Answer the questions below regarding the heating of a house in the Midwestern United States. Assume the following.

- The house has 2,000 square feet of living space.
- 80,000 BTUs of heat per square foot are required to heat the house for the winter.
- Natural gas is available at a cost of \$5.00 per thousand cubic feet.
- One cubic foot of natural gas supplies 1,000 BTUs of heat energy.
- The furnace in the house is 80 percent efficient.

(a) Calculate the following, showing all the steps of your calculations, including units.

- The number of cubic feet of natural gas required to heat the house for one winter
- The cost of heating the house for one winter

(b) Identify and describe three actions the residents of the house could take to conserve heat energy and lower the cost of heating the house.

(c) The residents decide to supplement the heating of the house by using a wood-burning stove. Discuss two environmental impacts, one positive and one negative, of using the wood-burning stove.

a. ~~80,000 BTUs~~ : ~~1,000 BTUs~~ =

i.  $80,000 \text{ BTUs/ft}^2 \times 2,000 \text{ sq ft} = 160,000,000 \text{ BTUs}$

$160,000,000 \text{ BTUs} / 1,000 \text{ BTUs/ft}^3 = 160,000 \text{ ft}^3 \text{ of natural gas}$

ii.  $160,000 \text{ ft}^3 \text{ natural gas} / 1,000 \text{ ft}^3 \text{ natural gas} = 160$

$160 \cdot \$5.00 = \$800.00$        $\$800.00 \cdot .2 = \$160.00$        $\$800.00 + \$160.00 = \$960.00$

b. To conserve heat energy and lower the cost of heating the house many steps can be taken by residents to accomplish this.

One action they can take is to call their gas company to come to their house and perform a thermal image scan on the house.

The service is usually free and it looks for places in the home where heat is escaping. Once these problem areas are found the resident can then super-insulate these areas to keep the heat in and the cold out. These areas are usually found around windows and where walls meet. To solve the problem the replacement of the windows and insulating material would be needed.

Another option is to find a more efficient heating source. By replacing the furnace with a more efficient one the amount of gas used will ~~also~~ decrease. The use of solar energy, whether directly or indirectly, is a cheap and efficient way to heat a home. This can be accomplished by just letting sun in or using the electricity from the PV cells to generate heat.

Alternative three could be to operate the furnace at a lower temperature. This decreases the need of the gas but would make the house cooler. The people ~~who~~ would need to wear thicker clothes.

C.

One positive aspect of using a wood-burning stove is that it doesn't use a non-renewable fuel. Natural gas, though in abundance now, is depleting and will not be around forever. This also cuts down on the land disturbed by the gas companies that need to find the supply of natural gas to fit the demand. If there is a lower demand then the supply needed isn't as large, lessening the need for more drilling.

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ADDITIONAL PAGE FOR ANSWERING QUESTION 1

The negative aspect of using a wood-burning stove is the use of the wood itself. Though it is not completely a non-renewable resource, at the rate forests are being cut down it acts as if it is. Forests, especially old growth forests such as those in Northwest U.S., are being cut down too fast and not given the ~~same~~ minimum time of 200 years to replenish. If more and more people turn to wood-burning stoves to heat their home an even more rapid deforestation will occur.

With this more rapid deforestation many more problems also arise. The loss of forests aid in erosion of top soil and make it easier for flooding to occur due to the loose soil.

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- The furnace in the house is 80 percent efficient.

(a) Calculate the following, showing all the steps of your calculations, including units.

- The number of cubic feet of natural gas required to heat the house for one winter
- The cost of heating the house for one winter

(b) Identify and describe three actions the residents of the house could take to conserve heat energy and lower the cost of heating the house.

(c) The residents decide to supplement the heating of the house by using a wood-burning stove. Discuss two environmental impacts, one positive and one negative, of using the wood-burning stove.

$$(a) \quad i.) \quad \frac{80,000 \text{ BTU}}{\text{ft}^2} \cdot \frac{1}{.8} = 100,000 \text{ BTU needed / sq. ft.}$$

$$100,000 \text{ BTU/ft}^2 \cdot 2000 \text{ sq. ft.} = 200,000,000 \text{ BTU}$$

$$200,000,000 \text{ BTU} \cdot \frac{1 \text{ ft}^3}{1000 \text{ BTU}} = \boxed{200,000 \text{ cu. ft. of natural gas}}$$

$$ii.) \quad 200,000 \text{ cu ft.} \cdot \frac{\$5.00}{1000 \text{ cu ft.}} = \boxed{\$1,000}$$

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

b) The residents could keep the house at a lower temperature during the day when no one is home and/or at night when everyone is bundled up in bed. Also, the residents could check the seals on their windows and doors to see if they need to be replaced with ~~more~~ ones that trap heat better. Finally, the residents could buy a furnace with a higher efficiency.

c) The wood-burning stove will supplement the heat provided by the furnace, thereby decreasing the amount of natural gas used. This will help preserve the stores of natural gas and avert some of the pollution caused by natural gas extraction. However, the residents will be using wood instead. The burning of wood will lead to greater deforestation.

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- The furnace in the house is 80 percent efficient.

(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 one winter

(ii) The cost of heating the house for one winter

(b) Identify and describe three actions the residents of the house could take to conserve heat energy and lower the cost of heating the house.

(c) The residents decide to supplement the heating of the house by using a wood-burning stove.

Discuss two environmental impacts, one positive and one negative, of using the wood-burning stove.

(a) First, to calculate the number of cubic feet of natural gas, how many BTUs of heat ~~are~~ needed to heat a house that has 2000 square feet of living space needs to be calculated. So, multiply 80,000 BTUs of heat per square foot by the 2000 square feet of living space. The answer is 160,000,000 BTUs of heat for a 2000 sq. foot house. Then, to calculate the number of cubic feet of natural gas needed, 160,000,000 BTUs of heat is divided by the 1000 BTUs of heat energy per one cubic foot. The answer is 160,000

cubic feet of natural gas. In conclusion, 160,000 cubic feet of natural gas is required to heat the house for one winter.

To find the cost of heating the house for one winter, the cost of natural gas multiplied by the number of ~~1000~~ <sup>cubic</sup> ~~feet~~ feet required to heat the house. First, since the cost is per thousand cubic feet, 1000 <sup>cubic feet</sup> is divided into 160,000 <sup>cubic</sup> feet of natural gas. The answer is 160 cubic feet. Then, 160 cubic feet is multiplied by \$5.00 to get \$800. It costs \$800 to heat the house for one winter.

b) The residents of the house could buy double or triple paned windows to replace their old ones. This will conserve heat energy by not allowing heat to escape outside. They could also weather-strip all their doors to prevent heat from leaking to the outside. A third step they might take is to buy a more efficient furnace. Their furnace only <sup>works 50%</sup> efficiently. They could buy another furnace that ~~works~~ <sup>works</sup> more efficiently.

c) - One environmental impact of a wood-burning stove is that it consumes a natural resource, wood, that takes time to ~~reproduce~~ renew. Another environmental impact is it does not use up electricity. It is a natural way to receive heat.