

## CHAPTER 12 NONRENEWABLE ENERGY RESOURCES

**PREPARE TO DO THE MATH****Knowing Units of Energy**

Units of energy/power can often be difficult for students to understand. It is important to go over several different units and prefixes. What follows are some of the units and prefixes, which have been used on past AP environmental science exams.

First, energy is measured in joules, but in some fields other units such as kilowatt-hours and kilocalories are also used.

**Watt** A kilowatt-hour (kWh) is the amount of energy expended by a 1 kilowatt (1000 watts) device over the course of one hour. Often measured in the context of power plants and home energy bills.

**Kilo** (means 1,000 or  $10^3$ ) 1 kW =  $10^3$  watts

**Mega (M)** (means 1,000,000 or  $10^6$ ) 1 MW =  $10^6$  watts

**Btu** (British Thermal Unit) Btu is a unit of energy used in the United States. In most other countries it has been replaced with the *joule*. A Btu is the amount of heat required to raise the temperature of 1 pound of water by 1 degree F. 1 watt is approximately 3.4 Btu/hr.

**Cost to run an appliance**

A household's electric bill can be separated into three parts. The three parts are electrical appliances, heating/cooling, and the hot water heater. Calculate the individual cost to operate certain appliances.

Use the formula below to calculate energy of individual appliances:

$$\text{Step 1: } \frac{(\text{watts})(\text{hours used per day})(365 \text{ days})}{1000} = \text{_____ total kWh used}$$

$$\text{Step 2: } (\text{total kWh used}) (\text{price per kWh}) = \text{_____}$$

The typical price per kWh varies from about \$0.085 to \$0.110, which is 8.5 to 11 cents per kWh.

**Try it:** A small house uses two lamps. Both lamps have 60-watt incandescent light bulbs which are used 3 hours a day. The family watches 2 hours of television. The HD television uses 200 watts per hour. Finally, they run the ceiling fan in the living room while watching 2 hours of television. It uses 90 watts per hour. The cost per kWh hour is \$0.105 or 10.5 cents. **Calculate the yearly bill for all appliances**

**Check your Answer:** The total yearly cost to operate the three appliances is \$36.03 per year

## FREE RESPONSE QUESTIONS

1. Many college students have a mini fridge in their dorm room. A standard mini fridge costs roughly \$100, uses about 100 watts of electricity, and can be expected to last for 5 years. The refrigerator is plugged into an electrical socket 24 hours a day, but is usually running only about 12 hours a day. Assume that electricity costs \$0.10/kWh.
  - (a) Calculate the lifetime monetary cost of owning and operating the refrigerator. (2 points)
  
  - (b) Assume that the electricity used to power the refrigerator comes from a coal-burning power plant. One metric ton of coal contains 29.3 GJ (8,140 kWh) of energy. Because of the inefficiency of electricity generation and transmission, only one-third of the energy in coal reaches the refrigerator. How many tons of coal are used to power the refrigerator during its lifetime? (2 points)
  
  - (c) Assume that 15 percent of the mass of the coal burned in the power plant ends up as coal ash, a potentially toxic mixture that contains mercury and arsenic. How many tons of coal ash are produced as a result of the refrigerator's electricity use over its lifetime? (2 points)
  
  - (d) What externalities does your answer from part (a) not include? Describe one social and one environmental cost associated with using this appliance. (2 points)
  
  - (e) Describe two ways a college student could reduce the electricity use associated with having a mini fridge in his or her dorm room. (2 points)

2. A number of U.S. electric companies have filed applications with the Nuclear Regulatory Commission for permits to build new nuclear power plants to meet future electricity demands.
- (a) Explain the process by which electricity is generated by a nuclear power plant. (2 points)
  
  
  
  
  
  
  
  
  
  
  - (b) Describe the two nuclear accidents that occurred in 1979 and 1986, respectively, that led to widespread concern about the safety of nuclear power plants. (2 points)
  
  
  
  
  
  
  
  
  
  
  - (c) Discuss the environmental benefits of generating electricity from nuclear energy rather than coal. (2 points)
  
  
  
  
  
  
  
  
  
  
  - (d) Describe the three types of radioactive waste produced by nuclear power plants and explain the threats they pose to humans. (2 points)
  
  
  
  
  
  
  
  
  
  
  - (e) Discuss the problems associated with the disposal of radioactive waste and outline the U.S. Department of Energy's proposal for its long-term storage. (2 points)

## MEASURING YOUR IMPACT

**Choosing a Car: Conventional or Hybrid?** One person buys a compact sedan that costs \$15,000 and gets 20 miles per gallon. Another person pays \$22,000 for the hybrid version of the same compact sedan, which gets 50 miles per gallon. Each owner drives 12,000 miles per year and plans on keeping the vehicle for 10 years.

- (a) A gallon of gas emits 20 pounds of CO<sub>2</sub> when burned in an internal combustion engine. The average cost of a gallon of gas over the 10-year ownership period is \$3.00.
- (i) Calculate how many gallons of gas each vehicle uses per year.
- (ii) Calculate the cost of the gas that each vehicle uses per year.
- (iii) Calculate the amount of CO<sub>2</sub> that each vehicle emits per year.

- (b) Based on your answers to questions i–iii, complete the data table below.

Year of operation	Sedan: total costs-purchase and gas (\$)	Sedan: cumulative CO <sub>2</sub> emissions (pounds)	Hybrid: total costs-purchase and gas (\$)	Hybrid: cumulative CO <sub>2</sub> emissions (pounds)
1	16,800	12,000	22,720	4,800
2	18,600	24,000	23,440	9,600
3	20,400	36,000	24,160	14,400
4	22,200	48,000	24,880	19,200
5	24,000	60,000	25,600	24,000
6	25,800	72,000	26,320	28,800
7	27,600	84,000	27,040	33,600
8	29,400	96,000	27,760	38,400
9				
10				

- (c) Use the data in the table to answer the following questions:
- (i) Estimate how many years it would take for the hybrid owner to recoup the extra cost of purchasing the vehicle based on savings in gas consumption.
  
  - (ii) After the amount of time determined in (i), compare and comment on the total costs (purchase and gas) for each vehicle at that time.
  
  - (iii) Over the 10-year ownership period, which vehicle is the more economically and environmentally costly to operate (in terms of dollars and CO<sub>2</sub> emissions), and by how much?
- (d) Suggest ways that the owner of the conventional car could reduce the overall yearly CO<sub>2</sub> emissions from the vehicle.
- (e) Suggest ways that the hybrid owner could become carbon-neutral in terms of operating the vehicle.

## FREE RESPONSE QUESTIONS FROM PREVIOUS AP EXAMS

Year	Question	Content
1998	3	<ul style="list-style-type: none"> <li>Identify 3 parts of a nuclear power plant?</li> <li>What are two environmental problems associated with nuclear power?</li> </ul>
1999	2	<ul style="list-style-type: none"> <li>What is the difference between renewable and nonrenewable resources?</li> <li>Describe resource use in developing vs. developed countries.</li> <li>What does the term sustainable mean? Can resources be sustainable?</li> </ul>
2000	1 **	<ul style="list-style-type: none"> <li>Calculate BTU's of heat needed to generate electricity each day, calculate the pounds of coal consumed each day, calculate the sulfur content released by the power plant each day.</li> <li>What are two ways a fossil fuel burning power plant can reduce SO<sub>x</sub> emissions?</li> <li>Why are SO<sub>x</sub> emissions a big problem environmentally?</li> </ul>
2001	1 **	<ul style="list-style-type: none"> <li>Calculate the number of cubic feet of natural gas required to heat the house in the winter.</li> <li>How can homeowners be more energy efficient in their own home? What are three things they can do?</li> <li>What is one advantage and one disadvantage of using a wood burning stove to supplement the heat in one's home?</li> </ul>
2004	3	<ul style="list-style-type: none"> <li>How is low-level and high-level radioactive waste different? Give an example of a specific isotope that may be present in the waste.</li> <li>What is a radioactive depository? Describe how Yucca Mountain in</li> </ul>
		<p>Nevada fits into the term depository. What are two other long-term management options for nuclear waste?</p> <ul style="list-style-type: none"> <li>How does ionizing radiation exposure affect human health?</li> </ul>
2005	3	<ul style="list-style-type: none"> <li>What are the steps to restoring land that once was used for coal extraction?</li> <li>Why would arid land be harder to restore?</li> <li>What are some environmental impacts that sulfur content from the remains of coal can have on the reclamation process?</li> <li>What are two environmental impacts coal has on our environment?</li> <li>Why is coal consumption in the US likely to increase?</li> </ul>
2005	4 **	<ul style="list-style-type: none"> <li>How many days would the technically recoverable oil resource in ANWR supply the total US demand for oil?</li> <li>What are two characteristics of a tundra biome? How is the tundra a fragile ecosystem, which makes it susceptible to human impact?</li> <li>If ANWR were developed for oil, what activities would impact the environment?</li> <li>What are two major uses for oil in the US and how can US citizens be more energy efficient when dealing with oil?</li> </ul>
2007	2 **	<ul style="list-style-type: none"> <li>Calculate the amount of water the family uses and the yearly cost of electricity for the family to shower.</li> <li>Replacing the hot water heater with an energy efficient hot water heater, how many days would it take to recoup a \$1000 investment?</li> <li>Describe two measures the family could do to reduce overall water usage.</li> <li>Describe two energy efficient measures the family could adapt to reduce total energy usage.</li> </ul>