Energy AP Exam Prep

due: Exam #7 Test Day

Temperature Conversions

How to convert Celsius temperatures to Fahrenheit

- Multiply the Celsius temperature by 9/5.
- Add 32^{o} to adjust for the offset in the Fahrenheit scale.
  - 9/5(^{o}C)+ 32 = ^{o}F

Mental math method to convert from Celsius to Fahrenheit relies on the ratio of 9/5 (1.8). 1.8 is equivalent to 2 - 0.2

- Double the Celsius temperature (multiply by 2).
- Take 1/10 of this number (2 * 1/10 = 0.2) and subtract it from the number above.
- Add 32^{o} to adjust for the offset in the Fahrenheit scale.

Convert ^{o}C to Fahrenheit:

1. 0^{o}C
2. 55^{o}C
3. 100^{o}C

Calculating Half-Lives

Strontium-90 is a radioactive waste product from nuclear reactors. It has a half-life of 29 years.

1. How many years will it take for a quantity of strontium-90 to decay to 1/16 of its original mass?

2. You have 180 g of a radioactive substance. It has a half-life of 265 years. After 1,325 years, what mass remains?

Heating a House

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.

   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.

Coal-Fired Electric Plants

1. A large, coal-fired electric power plant produces 12 million kilowatt-hours of electricity each day. Assume that an input of 10,000 BTU's of heat is required to produce an output of 1 kilowatt-hour of electricity.
   A. Showing all steps in your calculations, determine the number of
      i. BTU's of heat needed to generate the electricity produced by the power plant each day,

      ii. pounds of coal consumed by the power plant each day, assuming that one pound of coal yields 5,000 BTU's of heat,

iii. pound of sulfur released by the power plant each day, assuming that the coal contains one percent sulfur by weight..

B. The Environmental Protection Agency (EPA) standard for power plants such as this one is that no more than 1.2 pounds of sulfur be emitted per million BTU's of heat generated. Using the results in part (a), determine whether the power plant meets the EPA standard.

C. **Describe** two ways by which a fuel-burning electric power plant can reduce its sulfur emissions.

D. **Discuss** why sulfur emissions from coal-fired power plants are considered an environmental problem and **describe** one negative effect on an ecosystem that has been associated with sulfur emissions.

2. West Fremont is a community consisting of 3,000 homes. A small coal-burning power plant currently supplies electricity for the town. The capacity of the power plant is 12 megawatts (MW) and the average household consumes 8,000 kilowatt hours (kWh) of electrical energy each year. The price paid to the electric utility by West remount residents for this energy is $0.10 per kWh. The town leaders are considering a plan, the West Fremont Wind Project (WFWP), to generate electricity using 10 wind turbines that would be located on the wooded ridges surrounding the town. Each wind turbine would have a capacity of 1.2 MW and each would cost the town $3 million to purchase, finance, and operate for 25 years.
   A. Assuming that the existing power plant can operate at full capacity for 8,000 hrs/yr, how many kWh of electricity can be produced by the plant in a year?

B. At the current rate of electrical energy use per household, how many kWh of electrical energy does the community consume in one year?

C. **Compare** your answers in (A) and (B) and explain why you would or would not expect the numbers to be the same.

D. Assuming that the electrical needs of the community do not change during the 25-year lifetime of the wind turbines, what would be the cost to the community of the electricity supplied by the WFWP over 25 years? Express your answer in dollars/kWh.

E. **Identify** and **explain** TWO environmental benefits to West Fremont of switching from coal to wind power and TWO environmental costs to West Fremont of switching from coal to wind power.

Electric Vehicles

1. Electric vehicles often have been proposed as an environmentally sound alternative to the gasoline engine for transportation. In response to state initiatives, the penetration of electric vehicles into the transportation sector of the United States remains modest.
    A. **Identify** and **describe** two <u>environmental</u> benefits to using electric vehicles in place of gasoline-powered engines for transportation.

    B. **Estimate** the potential reduction in petroleum consumption (in gallons of gasoline per year) that could be achieved in the United States by introducing electric vehicles under the following assumptions:
        1. The mileage rate for the average car is 25 miles per gallon of gasoline.
        2. The average car is driven 10,000 miles per year.
        3. The United States has 150 million cars.
        4. 10 percent of United States cars could be replaced with electric vehicles.

    C. Some people have suggested that electric vehicles only shift the emission of air pollutants from dispersed sources to point sources. **Explain** and **defend** or refute this statement.

    D. **Propose** two potential new United States government policies that would encourage the widespread use of electric vehicles. **Explain**.