Date ____________

APES Energy Problems: Take 2

1. Refrigeration is costly in terms of energy usage. A single-door, manual defrost refrigerator uses 600 kWh/yr. A large, 20 cu.ft. two-door automatic defrost refrigerator uses 1880 kWh/yr. How many kcal/yr does each type of refrigerator use? (1kWh = 860kcal)

Single-door - $\frac{600kWh}{1\ year} \times \frac{860kcal}{1\ kWh}$ = **516,000 kcal/yr** Double-door - $\frac{1880kWh}{1\ year} \times \frac{860kcal}{1\ kWh}$ = **1,616,800 kcal/yr**

2. Assume you use an air conditioner for a total of 137 days, 24 hours per day, at a rate of 7.25 kWh per hour. Assume the cost per kWh is the New York rate of $0.21/kWh and 1 kWh = 3400 BTUs.

   a.) Calculate the total number of kWh used per year.

   $\frac{137days}{1} \times \frac{24\ hr}{1\ day} \times \frac{7.25kWh}{1\ hr}$ = **23,838 kWh**

   b.) Determine the cost of air conditioning for one year.

   $\frac{23838\ kWh}{1\ yr} \times \frac{\$0.21}{1kWh}$ = **$5005.98/yr**

   c.) How many kcal are used per year?

   $\frac{23838\ kWh}{1\ yr} \times \frac{860\ kcal}{1kWh}$ = **20500680 kcal/yr**

   d.) How many BTUs are used in one year?

   $\frac{23838\ kWh}{1\ yr} \times \frac{3400\ BTU}{1\ kWh}$ = **81,049,200 BTU/yr**

3. Transportation energy is costly.

   a.) Calculate the gallons of gas use just for going to the supermarket in one year if you take 5 trips to the store per week, traveling 7.5 miles roundtrip, and your car gets 22 miles per gallon.

   $\frac{5\ trips}{1\ week} \times \frac{52\ week}{1\ yr} \times \frac{7.5miles}{1\ trip} \times \frac{1\ gallon}{22\ miles}$ = **88.64 gallons/yr**

   b.) Convert the gallons to kcal/year if there are 32000 kcal per gallon.

   . $\frac{88.64\ gallons}{1\ yr} \times \frac{32000\ kcal}{1\ gallon}$ = **2,836,363.64 kcal/yr**

4. 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 15,000 miles per year.
    3. The United States has 250 million cars.
    4. 10 percent of United States cars could be replaced with electric vehicles.

$$\frac{1\text{ gallon}}{25\text{ miles}} \times \frac{15000\text{ miles}}{1\text{ car} - 1\text{ yr}} \times \frac{250{,}000{,}000\text{ cars}}{1} \times .10 = \mathbf{1.5 \times 10^{10}\text{ gallons/yr}}$$

5. Suppose your electric lights use 400 watts of power and average four hours per day, every day for one year. Assume the cost per kWh is the New York rate of $0.21/kWh.

   Remember … last time we did this…
   you were given the fact that 1 Watt = 1J/s **and** that 1kWh = 3.6 x10^6 J

   a.) How many kWh per year does this represent?

$$400\text{ watts} = \frac{400\text{ J}}{\text{sec}} \times \frac{60\text{sec}}{1\text{ min}} \times \frac{60\text{ min}}{1\text{ hr}} \times \frac{4\text{ hrs}}{1\text{ day}} \times \frac{365\text{ days}}{1\text{ yr}} \times \frac{1\text{ kWh}}{3600000\text{ J}} = \mathbf{584\text{ kWh/yr}}$$

   b) If replacing the lights with a fluorescent bulb would save 60 watts of power, what savings in kWh does this represent in one year?

$$60\text{ watts savings} = \frac{60\text{ J}}{\text{sec}} \times \frac{60\text{sec}}{1\text{ min}} \times \frac{60\text{ min}}{1\text{ hr}} \times \frac{4\text{ hrs}}{1\text{ day}} \times \frac{365\text{ days}}{1\text{ yr}} \times \frac{1\text{ kWh}}{3600000\text{ J}} = \mathbf{87.6\text{ kWh/yr}}$$

or…..

$$340\text{ watts} = \frac{400\text{ J}}{\text{sec}} \times \frac{60\text{sec}}{1\text{ min}} \times \frac{60\text{ min}}{1\text{ hr}} \times \frac{4\text{ hrs}}{1\text{ day}} \times \frac{365\text{ days}}{1\text{ yr}} \times \frac{1\text{ kWh}}{3600000\text{ J}} = 496.4\text{ kWh/yr}$$

584 kWh/yr (incandescent usage) – 496.7 kWh/yr (fluorescent usage) = **87.6 kWh/yr saved**

c) If the fluorescent bulb costs $18.00 but lasts for 10 years, would you consider it a wise investment over incandescent bulbs? Explain your answer.

By switching to the fluorescent bulb, you would save $.21/ kWh (87.6 kWh) = $18.40/yr – the energy savings of a fluorescent bulb pays for itself in just about a year and you will save another 9 years of energy usage (9 x $18.40 = approximately $166 savings)

Date ________

Sample AP Problem: Heating the House!

Answer the questions below regarding the heating of a house in the Midwestern United States. Use the assumptions in the table below to perform the calculations that follow.

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 number of cubic feet of natural gas required to heat the house for one winter if the furnace was 100% efficient. Show all the steps of your calculations, including units.

$$\frac{2000 \text{ sq ft}}{1} \times \frac{80{,}000\text{BTU}}{1 \text{ sq ft}} \times \frac{1 \text{ ft}^3 \text{ natural gas}}{1000\text{BTU}} = \mathbf{160{,}000 \text{ ft}^3 \text{ natural gas}}$$

(b) Calculate the cost of heating the house for one winter if the furnace was 100% efficient.

$$\frac{160{,}000 \text{ ft}^3 \text{ natural gas}}{1} \times \frac{\$15.00}{1000 \text{ ft}^3 \text{ natural gas}} = \mathbf{\$800.00}$$

(c) Determine the number of cubic feet of natural gas and cost of heating with a furnace at 80% efficiency.