Date ________________

# APES Energy Problems

**The Basics:**

**Energy:** The basic unit of energy is a Joule (J).
Other units are kilojoule, calorie, British Thermal Unit (BTU), and therm.

**Power**: Power is the rate at which energy is used. **Power (watts) =** $\frac{\textbf{Energy (joules)}}{\textbf{time (secs)}}$

**1 kJ = 1000J**

**1W = 1J/s (1Watt = 1 Joule per second)**

**1kW = 1000 J/sec (1kJ/sec)**

} these are measurements of the rate of energy usage

**1kWh = 3600 KJ (3.6 x $10^6$ J)** → this is the measurement of the total amount of energy used in one hour

1. The "old-style" 100 Watt incandescent light bulb uses 100 J/sec of electrical energy. If it is 5% efficient, then the bulb converts 5% of the electrical energy into light and 95% is wasted by being transformed into heat. (Ever felt a hot light bulb?)

   a. How is the First Law of Thermodynamics referenced above?

   **Energy is neither created nor destroyed, but it can transform from one type to another. The electrical energy was transformed into light and into heat.**

   b. How is the Second Law of Thermodynamics referenced above?

   **When energy is changed from one form to another, some of the useful energy is degraded to lower-quality, more dispersed, higher entropy, less useful energy (usually dispersed heat). In the case above, only %5 is converted into useful light energy, and the rest is lost as heat.**

**Practice Problems:**

2. How much energy, in kJ, does a 75 watt light bulb use then it is turned on for 25 minutes?
(Hint to get started: Using the power equation above, 1 watt = 1 J/sec, therefore 75 watts = 75 J/sec.
You are allowed to immediately indicate that and then proceed with dimensional analysis.)

$$75 \text{ watts} = \frac{75\text{ J}}{\text{sec}} \times \frac{60\text{sec}}{1\text{ min}} \times \frac{25\text{ min}}{1} \times \frac{1\text{ KJ}}{1000\text{ J}} = \textbf{112.5 kJ}$$

3. The kilowatt-hour, or kWh, is the measure of your total energy use.

a. Assume your electric bill showed you used 1355 kWh over a 30-day period. Find the energy used, in kJ, for the 30 day period.

$$\frac{1355\text{ kWh}}{1} \times \frac{3600\text{ kJ}}{1\text{ kWh}} = \mathbf{4{,}878{,}000\ kJ\ \ or\ \ 4.878 \times 10^6\ kJ}$$

b. Find the energy used in J/day.

$$\frac{4{,}878{,}000\text{ kJ}}{30\text{ days}} \times \frac{1000\text{ J}}{1\text{ kJ}} = \mathbf{162{,}600{,}000\ J/day\ \ or\ \ 1.626 \times 10^8\ J/day}$$

c. At the NY rate of $0.21/kWh, what will your electric bill be for this month?

$$\frac{1355\text{ kWh}}{1} \times \frac{\$0.21}{1\text{ kWh}} = \mathbf{\$284.55}$$

4. Remember: a 100-Watt incandescent light bulb is 5% efficient.

a.) How much energy (in Joules) does it use in 12 hours of operation?

$$100\text{ watts} = \frac{100\text{ J}}{\text{sec}} \times \frac{60\text{ sec}}{1\text{ min}} \times \frac{60\text{ min}}{1\text{ hr}} \times 12\text{ hours} = \mathbf{4{,}320{,}000\ J\ \ or\ \ 4.32 \times 10^6\ J}$$

b.) Convert total energy use to kWh

$$\frac{4.32 \times 10^6\text{ J}}{1} \times \frac{1\text{ kWh}}{3.6 \times 10^6\text{ J}} = \mathbf{1.2\ kWh}$$

c.) How much energy does the bulb convert to light during 12 hours?

$$4.32 \times 10^6\text{ J} \times .05 = \mathbf{216{,}000\ J}$$

5. An electric clothes dryer has a power rating of 4000 W. Assume a family does 5 loads of laundry each week for 4 weeks. Assume each dryer load takes 1 hour.

a.) Find the energy used in J.

$$4000\text{ watts} = \frac{4000\text{ J}}{\text{sec}} \times \frac{60\text{ sec}}{1\text{ min}} \times \frac{60\text{ min}}{1\text{ hr}} \times \frac{1\text{ hr}}{1\text{ load}} \times \frac{5\text{ loads}}{1\text{ week}} \times \frac{4\text{ weeks}}{1} = \mathbf{288{,}000{,}000\ J\ \ or\ \ 2.88 \times 10^8\ J}$$

b.) Find the energy used in kWh.

$$\frac{288{,}000{,}000\text{ J}}{1} \times \frac{1\text{ kWh}}{3{,}600{,}000\text{ J}} = \mathbf{80\ kWh}$$

c.) Find the operating cost for 4 weeks. Assume cost is $0.21/kWh

$$\frac{80\text{ kWh}}{1} \times \frac{\$0.21}{1\text{ kWh}} = \mathbf{\$16.80}$$