Big Exam #1 Use both sides. Put your name at the end. No calculators… answers are accurate to +/- 30%.

#1) I told you in class that USA consumes primary energy at about 10 kW. How much energy is this per year for the country? Please put answer in ExaJoules or Quads. Yes, I should have written *10 kW per person*. At the same time, in this class, I would expect you to know approximate power consumptions. In the future, please know these approximate numbers of have them on your formula sheet, consider if the numbers make sense, and certainly ask if you are not sure. If this were a real assessment, I'd have given you full credit if you missed this because of my poor wording, but for now, I marked it down to a "B" if you didn't multiply by USA population. You may wonder that there's no way we could be using energy at a rate of 10 kW. However, this includes not only your gasoline consumption driving, but also your portion of the 747 fuel of your plane, as well as your portion of the energy used to build our roads and government buildings, by the F-22 flying patterns in the Persian Gulf, and the energy to building the wall on our southern border.

#2) A friend told me that we burn energy equivalent to a 100 W lightbulb. No wonder the room is hot when there's lots of people in it. If a person is really a 100W lightbulb, how many Calories would we need to eat daily? Is this about right? – remember a dietary Calorie is a kcal.

In summary, I expect you to lay out the conceptual plan for what you will do: For both of these questions, please start with $P = \frac{\Delta E}{\Delta t}$. I also expect that you'll reflect on your answer to see if it makes sense. This will become easier as we learn more.

$P = \frac{\Delta E}{\Delta t}$ $\quad E_{year} = P \cdot \Delta t = P \cdot 1\,year$ $\quad P = 10\,kW$

or remember $1\,yr = 8760\,hrs = \pi \times 10^7\,s$

$E_{year} = 10\,kW \cdot 1\,year$

$= 10^4\,J/s \cdot 1\,year \cdot \frac{365\,days}{yr} \cdot \frac{24\,hr}{day} \cdot \frac{3600\,s}{hr}$

$\approx 10^4\,J \cdot \frac{1000}{3} \cdot \frac{100}{4} \cdot \frac{10{,}000}{3}$

$E_{year} \approx \frac{10^{13}\,J}{36} \approx \frac{100}{100}\frac{3}{100}10^{13}\,J \approx 3 \times 10^{11}\,J$

But this is just for 1 person!

$E_{USA} = E/person \cdot Population$

$\approx 3 \times 10^{11}\,J/per \cdot \frac{1}{3} \times 10^9\,people \approx 10^{20}\,J = 100\,EJ \approx 100\,Quad$

Answer!

1 Quad = 1 Quadrillion BTU = $10^{15} \cdot 1055\,J = 1.055 \times 10^{18}\,J \approx EJ$

$P = \frac{\Delta E}{\Delta t}$ $\Delta E_{day} = P \cdot \Delta t = P_{person} \cdot 1\,day$

$\Delta E_{day} = 100W \cdot 1\,\cancel{day}\, \frac{24\,\cancel{hrs}}{\cancel{day}} \cdot \frac{3600\,s}{\cancel{hr}}$

$\approx 10^2 \frac{J}{\cancel{s}}\, \frac{100}{4} \cdot \frac{10^4}{3}\, \cancel{s}$

$= \frac{10^{\cancel{8}\,5}}{12}\, \cancel{J}\, \frac{\cancel{cal}}{4.2\,\cancel{J}} \frac{Cal}{1000\,\cancel{cal}} \approx \frac{10^5}{50}\; Cal$ (kcal)

$\approx 2000\; Cal$

Ok, This seems to be about right for average dietary intake!

Name_________________________________