

# CSC 400 Estimation Questions

September 2, 2008

Document your sources and describe your reasoning and assumptions in answering the following questions. For uncertain quantities, it is wise to consult more than one source. Do your own calculation rather than looking up the answers (which might very well be wrong).

1. How many grains of pollen does a typical Rochester resident inhale during the course of a year? How much total mass does this represent? How about over a lifetime? How does this compare to the particulate mass inhaled by a pack-a-day smoker? What happens to this particulate matter?
2. How many leaves are there on deciduous trees in Monroe county? What is the total dry mass of these leaves? How does the energy content of these leaves (if burned) compare to the total annual energy used for home heating in Monroe county?
3. How much dry biomass can be grown per unit area (e.g. hectare) per year in temperate climates (e.g. the US midwest) using the most productive known crops without extensive use of nitrogen fertilizer? What is the energy content of this dry biomass if burned? What fraction of the available solar energy is converted to chemical energy by this process? How efficiently can this chemical energy be converted to electrical energy? How does the overall efficiency compare to conventional solar-to-electric technologies?
4. Pressure has units of energy density (energy per unit volume). If this is interpreted as available energy in a compressed gas, how does the energy density of compressed air held at pressures that can be contained in modern storage cylinders compare to that of gasoline? How does it compare to that of Lithium-ion batteries? With what efficiency can the air-pressure energy be converted to mechanical energy using current (compact, high power) pneumatic motors? (Note that because the “energy density” of the compressed air is a unitary, not a physical equivalence, this efficiency might theoretically be higher than 100%). What are the analogous conversion efficiencies for conventional gasoline engines and electric motors? What does all this imply about the potential practicality of compressed-air-powered cars?
5. How much energy per year does the average American consume in food? (Recall that food “calories” are thermodynamic kilocalories)  
How much energy per year does the average American consume in automobile fuel?  
How much energy per year does the average American consume for home heating?  
What are the analogous figures for China?  
How long would known oil reserves last if the entire world consumed oil at the per-capita rate of the US?