

CSC 400 Estimation Questions

September 4, 2012

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), that is, work from the most basic information you can find.

1. How much power is directly consumed by all computers operating in the United States? What if additional cooling energy is included? What percentage of total electrical usage does this represent? How much CO₂ is added to the atmosphere each year to generate this electricity? How does this compare with the CO₂ exhaled by humans in the US?
2. If all passenger car miles driven in the US were replaced with Chevy VOLT equivalent miles, how much additional electrical energy would be required (e.g. as a percent of current US usage)? If usage patterns scale directly as this proportion (i.e. no use of new “smart grid” technology) estimate the capital cost of new coal-fired plants required to produce the additional energy. Also estimate the capital cost of additional transmission infrastructure needed to distribute the additional power.
3. What fraction of the water currently on the surface of the earth has at some point been contained in a living cell? (almost) all of it? a modest fraction? (almost) none of it? You may take the current biosphere as a model and project it back as far as there has been a lot of life on earth. Don't forget single-cell organisms... Carefully spell out and justify other assumptions.
4. Combining diffusion and meteorological turbulent mixing, estimate the time scale required for two molecules of atmospheric nitrogen (N₂) initially separated by the mean distance between molecules in air (i.e. effectively neighbors) to lose any significant correlation in global (lat, long, altitude) position (e.g.. they are likely as not in different hemispheres). Is mixing time significantly (i.e. an order of magnitude or more) different in some dimensions (e.g. vertical) than others? Does the initial position of the pair of molecules (lat, long, elevation) make a significant difference in the answer?