Chm310 – Problem Set 3

Energy Calculations

The problems below are open-ended and much more like problems you will encounter in the real world than the usual "cookie cutter" problems from a textbook. We are more interested in your thought processes and assumptions used in answering them than in the final answer. Please work independently, i.e. no two solutions should be similar. Do quick "back-of-the-envelope" calculations of your own, using relevant information from the web or class as needed. You are going to have to estimate some quantities yourself. Identify the assumptions you are making and very quickly indicate the sources of information you are using, e.g. just indicate Wikipedia, if you used it. Keep your answers to one page or less per problem. Note that if you Google the answer and then reference a specific website that claims that "trees can meet the world's energy demands (e.g. Problem 1)", you won't get any credit. Rather, we are looking for calculations from first principles, as outlined below.

1. Energy from Biofuels

Do you agree with the statement in the text (page 292)?: "**At today's consumption levels the amount of land required to supply the world's energy needs entirely by biomass equals that of all agricultural land currently developed.**" To answer this problem, pick a couple of biofuels (e.g. trees, sugar cane, palm oil, …). Things you may have to consider are how much chemical energy they store and how rapidly they can get harvested. The world's energy needs are roughly 5×10^{20} J/year.

2. Planes and Cars

Do you agree with the following statement?: "**Roughly the same level of CO_2 is emitted if one flies to the West Coast from Toronto as if one were to drive.**" Do some simple calculations using information about energy consumption of cars and planes to make an informed decision. There will be a lot of assumptions in your calculation, so make sure to articulate them clearly.

3. Solar Energy

In the text, it is stated (page 367) that: an area of "**about 0.1% of the Earth's surface"** could supply all the world's energy needs if it was covered with solar photovoltaic cells. Do you agree? You can do the calculation by assuming that the solar panels track the sun at all times, and that all the energy is magically available to everyone and does not have to get transported/stored. These are big assumptions – you can comment on them if you want.