Manhattan Project — Assignment 6 — Reactors

All but the last problem below are straightforward plug-ins. So what is the point, other than becoming familiar with the equations and quantities involved? The point is to set things up well, to get answers clearly, and to avoid silly mistakes.

To do that, you need to: (a) name the quantities involved with variable names, (b) solve for the quantity you are interested in, (c) write down your input values, (d) do any needed units conversions, (e) check units, and only then (f) plug into a calculator.

Even at the last step of plugging into a calculator, you want to (g) handle the powers of 10 yourself (you don't need a calculator to do $10^{13} / 10^{-11}$ — it's just addition and subtraction), and (g) estimate in round numbers what the calculator should give you before you plug in to help catch the possibility of punching in silly values.

1. Reed Problem 5.1, p. 235

This is a really good power vs. energy problem. 1MW is a unit of power, not energy. Power is a rate of energy production (or energy consumption or energy flow). The important thing is that it is a rate. Similarly, 30,000 cubic feet / minute is a rate of air flow. It might help you think more concretely about this problem to ask what happens in 1 second. In that time, how many Joules of power are produced, and how many cubic feet of air are circulated.

In the equation $Q = mc\Delta T$, Q is the heat absorbed by the air, which is the energy that has to be carried away from the pile, m is the mass of the air, c is the specific heat of air, and ΔT is the temperature increase you are asked for.

2. Reed Problem 5.2

and

3. Reed Problem 5.3

These are both straightforward mass, density, volume, and units conversion problems.

4. Reed Problem 5.4

(a) Start by making a table, so that you know what it is the math is doing for you (continued on reverse).

4. Reed Problem 5.4, p. 235 (Cont'd)

In[6]:=
```
TableForm[
 PrependTo[Table[{i, If[i == 0 || i == 1, 0.0072 * Power[1.1, i], ""]}, {i, 0, 6}],
  {"Enrichment Round", "Concentration"}]]
```

Out[6]//TableForm=

Enrichment Round	Concentration
0	0.0072
1	0.00792
2	
3	
4	
5	
6	

Obviously you don't want to make a table with 51 entries to show the desired answer, unless that is your idea of a good time. So your next step is:

(b) Write down the equation for the *i*th table entry.

(c) The trick is to set the equation for the *i*th concentration equal to the final concentration, and then solve this equation for the enrichment round, *i*. This algebra requires logarithms, powers, and logarithms of powers!