Manhattan Project — Assignment 7 — Hanford Reactors

Same little sermon as at the beginning of Assignment 6:

Reed's problems are mostly plug-ins, although there are a couple of conceptual tricks to get started on 1 and 2 below. 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 at the last step (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 simplify $10^{13} / 10^{-11}$ into 10^{24} — that's just addition and subtraction). You also should (h) estimate in round numbers what the calculator will give you before you plug in to help catch the possibility of punching in silly values. I did that in class when we did Problem 5.7 on p. 235. For example, I said 400/45 is about 9, and then I said 9 is about 10, which is a very round number.

If you can get a round number answer without a calculator, it will greatly increase your confidence in the answer that the calculator gives. If they don't roughly agree something is wrong and you can probably figure out what.

1. Reed Problem 6.1, p. 269

You need the formula for the surface area of a cylinder (Reed is calling these annuli). Then because the water jackets are very thin cylinders, just multiply the surface area of the cylinder by its thickness to get its volume.

2. Reed Problem 6.2

The basic formula is this rearrangement of the definition of specific heat, C:

$\Delta T = \frac{E}{C\,M}$.

ΔT is the temperature rise, and E is the energy absorbed by the water. But the water is flowing by at a rate of r of 30,000 gallons per minute. And the energy that is being absorbed is specified as a power, P of 250MW which is 250MJ per second.

So divide numerator and denominator of the formula by some time.

So, $\Delta T = \frac{E/t}{C\,M/t}$. And that means that $\Delta T = \frac{P}{C\,r}$. The rest, as Trey says, is just units conversion.

3. Reed Problem 6.3

The idea is to find out how much plutonium is produced in a Hanford reactor.