

The Blob

(OZ, Vol 1. page 264)

A certain menacing biological culture (aka “The Blob”) grows at a rate proportional to its size. When it arrived unnoticed one Wednesday noon in Chicago’s loop, it weighed just one gram. By the 4 p.m. rush hour it weighed 4 grams.

The Blob has its “eye” on the Sears Tower, a tasty morsel weighing around 3×10^{12} grams. As soon as The Blob weighs 1000 times as much (i.e. 3×10^{15} grams), it intends to *eat* the Sears Tower. By what time must the Blob be stopped? Will Friday’s rush hour be delayed?

Newton’s Law of Cooling

(OZ, Vol 1. page 255)

It’s a winter day in Frostbite Falls, Minnesota---10 degrees below zero Celsius. Boris and Natasha stop at a convenience store for hot (initially 90°C) coffee to warm them on the cold, windy walk home. Two types of cups are available, environmentally destructive foam and politically correct cardboard.

Boris wants foam. “What do I care about the greenhouse effect?” he asks. “Besides, remember the proportionality constant k in Newton’s law of cooling

$$y' = k(y - C)$$

where C is the ambient temperature, y is the Celsius temperature of the coffee at time t , and t is the time measured in minutes? Well, for foam, $k = -.05$. For cardboard, k is a pathetic $-.08$.”

“Do what you want, Boris,” says Natasha. “I’d rather save the world. I’m having cardboard. And make mine decaf.”

- How long does Boris’s coffee stay above 70 degrees? How about Natasha’s? How hot is each cup after 5 minutes?
- Redo part (a) assuming that Boris and Natasha drink their coffee in the overheated (25°C) convenience store.
- What value of k is needed to assure that the coffee, starting at 90°C , is still 70°C after 5 minutes outdoors.

Carbon Dating

(From *Calculus in Context*, pg. 228)

Virtually all living things take up carbon as they grow. This carbon comes in two principal forms: Normal stable carbon $-\text{C}^{12}$ —and radioactive carbon-- C^{14} . C^{14} decays at a rate proportional to the amount of C^{14} remaining. While the organism is alive, this lost C^{14} is continually replenished. After the organism dies, through, C^{14} is no longer replaced, so the percentage of C^{14} decreases exponentially over time. It is found that after 5730 years, half of the original C^{14} remains. If an archeologist finds a bone with only 20% of the original C^{14} present, how old is the bone?