

Class activity

Introduction to Physical Sciences

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Q: What's the point of today's lab?

A: You'll see...

Exercise 1

Take sheets of paper: Printing paper and newspaper. Fold it as many times as you can. I mean *really* fold it in half, not just a bunch of fake folds.

1. How many times do you manage to fold it in half?
2. Build a *model* (by that, I mean: figure out an equation) for how the thickness of the paper object grows with the number of folds-in-half. In a similar vein, what happens to the area of paper you see?
3. What is the thickness of one sheet of paper? Using that, explain your observations in Q1, based on your model in Q2.
4. If you had to keep folding paper till the thickness of the paper became the distance between the earth and the moon, then how many times do you need to fold it? (The distance between the earth and the moon is approximately 384,000 km, on average.)¹

Exercise 2

"Compound interest is the eighth wonder of the world. He who understands it, earns it ... he who doesn't ... pays it."

– incorrectly attributed to Albert Einstein

1. Say you take a \$ 1 million home loan from a bank. The rate of interest (growth rate) is 7% per annum. Suppose you forgot to pay your installments (*oops!*) approximately how many years will it take for the amount you owe to double, to \$ 2 million? Is that compatible with the "*rule of seventy*"?

$$\text{Doubling time (in number of periods)} \approx \frac{0.7}{\text{rate of growth (in one period)}}$$

¹Hint: Douglas Adams might have been on to something ;-)

2. The United States budget deficit today is about \$ 1 trillion. How long does it take for the money *you owe to the bank* to become as large a number as the US budget deficit is today.

“There are 10^{11} stars in the galaxy. That used to be a huge number. But it’s only a hundred billion. It’s less than the national deficit! We used to call them astronomical numbers. Now we should call them economical numbers.”

– Richard Feynman (Physicist, and smart-ass, 1918-1988)

Exercise 3

You will do this exercise in class, depending on whether we have sufficient time left. If we don’t manage it in class time, you might enjoy doing it in your free time.

Suppose you were a consultant for a company which wants to market “zombie repellant spray” as the ultimate safeguard against zombies. To market their product, they want to use *FUD tactics*² to scare people into buying zombie safeguards. As a consultant, you are supposed to model a zombie outbreak.

Each zombie will need to feed on one non-zombie human each night, thereby infecting that human. Assume you start with a single zombie. How long does it take to turn the world’s human population into zombies?

Some remarks

1. In all the problems we did today, we made “reasonable” assumptions and approximations. The aim was not to get the exact number, but to get an intuition for how large or small they will be. Such problems are called “*Fermi problems*”³. The spirit of Fermi problems is something we try to incorporate in our class.

Part 4

Let’s watch some videos about [scales in the universe](#). We’ll spend some time in class talking about that.

²FUD stands for Fear, Uncertainty, Doubt. It is a notorious marketing strategy sometimes used by big companies to quash smaller ones.

³Named after the physicist Enrico Fermi, who was a whiz at using simple methods to get estimates of complicated problems. There are some interesting stories about the guy.