

# Giving Meaning to Large Numbers

## Physics and Mathematics of Sustainable Energy

### Friday, September 14, 2023

College of the Atlantic

The **goals** for today are for you to **practice**:

- Several techniques for giving meaning to very large numbers,
- Working with scientific notation,
- Thinking about how to communicate approximate quantities.

### Guidelines

- Please work in pairs or trios. When you are done, please scan this worksheet (as a pdf if at all possible), and upload to google classroom.
- This assignment is not graded, but I will look these over. I'm asking you to submit this mainly so that I can see how folks are doing in general, what questions people have, etc.

Names: \_\_\_\_\_

Team Name: \_\_\_\_\_

### Words for Big Numbers

$$\text{One million} = 1,000,000 = 10^6, \quad (1)$$

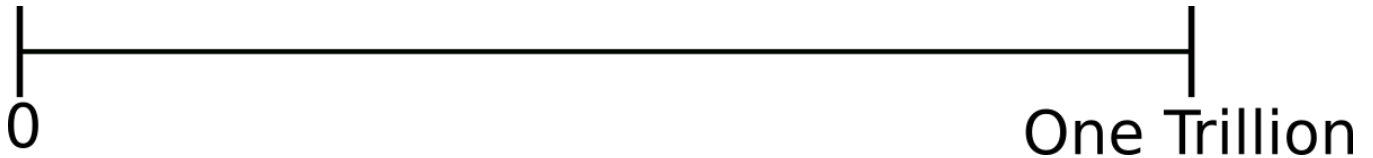
$$\text{One billion} = 1,000,000,000 = 10^9, \quad (2)$$

$$\text{One trillion} = 1,000,000,000,000 = 10^{12}, \quad (3)$$

Note: These words are not standard across different varieties of global Englishes, and do not have analogues in many other languages and cultures! These questions explore a number of different ways to make large numbers relatable, understandable, and easier to work with.

## Conceptualizing orders of magnitude

1. Below is a number line from one to one trillion. On that number line, indicate the locations of one million and one billion.



2. Time....
  - (a) How many days are in a million seconds?
  - (b) How many years are in a billion seconds?
  - (c) How many years are in a trillion seconds?

## Dividing a large number by another large number

1. The 2018 US national budget is around 4.4 trillion dollars. Included in this is 886 billion in military spending. US foreign aid (non-military) is around 33 billion.
  - (a) Convert all these numbers to per person.
  - (b) Briefly discuss the relative size of these numbers.
2. The net worth<sup>1</sup> of Jeff Bezos, the chairman of Amazon, is 185 billion US dollars. Amazon was founded 27 years ago. At what rate, in dollars per second, did Bezos accumulate wealth over these 27 years?
3. Repeat the above question but for a wealthy person from the US who might have a net worth of one million dollars after 30 years of work.

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<sup>1</sup>As of around a year ago. It's surely gotten even larger over the last year.

## How many Digits?

Answer these questions as if you were a normal person (i.e., not someone in a physics class).

1. An e-bike can travel at a speed of 15 mph. You want to travel via e-bike to visit your uncle who lives 50 miles away. Your uncle asks how long it will take to get there? How would you answer?
  
2. You and your friend operate a community kitchen that serves free, vegetarian meals. Today your friend will cook and you are going to the market to buy lentils. You have 40 dollars, and lentils cost three dollars per kilograms. Your friend asks how many kilograms of lentils you'll be able to get. How do you respond?

## Scientific Notation<sup>2</sup>

- Convert the following numbers to scientific notation:
  - 10000
  - 0.0004
  - 123000000
- Express the following quantities in Watts:
  - 1 MW
  - 2.4 GW
  - $6 \times 10^5$  W
  - 14000 kW
- Express the following quantities in kW:
  - 13 MW
  - 4 GW
  - $2.3 \times 10^4$  W
- Calculate the following, first without, and then with a calculator.
  - $(4 \times 10^6) \times (5 \times 10^3)$
  - $\frac{20 \times 10^9}{300 \times 10^6}$
  - $\frac{250}{10^3}$

It's ok if you're not good friends with scientific notation yet. Also, make sure that everyone in your group knows how to enter scientific notation on your calculator. It's easy to make mistakes when doing so.

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<sup>2</sup>is your friend. It really wants to help.