

Working with Large Numbers

Physics and Mathematics of Sustainable Energy

Friday, September 20, 2024

College of the Atlantic

The **goals** for today are:

- Practice working with scientific notation,
- Practice thinking about significant digits,
- Explore various techniques for giving meaning to very large numbers

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! I'm asking you to submit this mainly so that you get practice submitting things on google classroom.

Names: _____

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!

Good news: scientific prefixes *are* standard:

- kilo = k = 10^3
- mega = M = 10^6
- giga = G = 10^9

Scientific Notation¹

1. Convert the following numbers to scientific notation:

(a) 10000

(b) 0.0004

(c) 123000000

2. Express the following quantities in Watts:

(a) 1 MW

(b) 2.4 GW

(c) 6×10^5 W

(d) 14000 kW

3. Express the following quantities in kW:

(a) 13 MW

(b) 4 GW

(c) 2.3×10^4 W

4. Calculate the following, first without, and then with a calculator.

(a) $(4 \times 10^6) \times (5 \times 10^3)$

(b) $\frac{20 \times 10^9}{300 \times 10^6}$

(c) $\frac{250}{10^3}$

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.

¹is your friend. It really wants to help.

Digits

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

1. How many people live in Maine?
2. 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?
3. 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?

Making sense of large numbers. In energy, we often have to work with large, very large, and very very large numbers. These numbers are hard to understand: it is very difficult to grasp how much larger a billion is than a million. These warm-up exercises explore some ways to make sense of large numbers.

1. 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?

2. Here are some facts about the US national budget form 2018:

- 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.

3. The net worth of Elon Musk is approximately 200 billion dollars. Suppose that Musk has been accumulating this wealth for 30 years. At what rate, in dollars per second, did Musk accumulate his wealth?

4. 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.

5. Suppose you earn 20 dollars an hour. How many years of round-the-clock work would it take you to accumulate as much wealth as Elon Musk has?