Orders of Magnitude and Powers of 10 **Math 111**

Real-world numbers are often spread out over many orders of magnitude. So you have to be comfortable with powers of 10 and orders of magnitude. Remember these rules:

- Multiplying by 10 moves the decimal place of a number so that it gets one order of magnitude bigger.

  Example: $10 \times 57.6 = 576$ and $45. \times 10 = 450$.

- Dividing by 10 moves the decimal place so that it gets one order of magnitude smaller.

  Example: $\frac{130.}{10} = 13.$ and $\frac{0.751}{10} = 0.0751$

- Powers just mean repeated multiplication. Handle powers of 10 in scientific notation by moving the decimal place to adjust to the appropriate number of orders of magnitude.

  Example: $3.04 \times 10^6 = 3,040,000$ and $89 \times 10^{-3} = 0.089$

Questions

1. An average elephant weighs about 3,000 kg. An average mouse weighs about 2.0×10^{-2} kg. How many orders of magnitude larger is an elephant than a mouse?

2. The annual GDP (gross domestic product) of the United States was roughly $25.4 trillion in 2022. The GDP of Afghanistan is estimated to be about $14.3 billion. Roughly how many orders of magnitude larger is the US economy than Afghanistan's?

3. Approximately how many orders of magnitude is 9999 larger than 11?

Scientific notation is a convenient way to express numbers spread out over several orders of magnitude. Just write the number with the decimal place after the first (left-most) nonzero digit, multiplied by the appropriate power of 10.

$$\textbf{Example: } 6,700 = 6.7 \times 10^3 \text{ and } 0.04 = 4 \times 10^{-2}$$

4. Convert the following numbers into scientific notation.
   (a) The annual GDP of the United States: \$16.8 trillion

   (b) $(2 \times 10^2)^3$

   (c) 6% of 2 billion

   (d) $(3 \times 10^{-4})(2 \times 10^7)$

5. The small figure to the left contains one hundred, or 10^2, dots. Estimate the number of dots in the large figure as a power of 10.