

Everyday scientists deal with REALLY small numbers and REALLY BIG numbers. What challenges do you think they face?

What do you think are some examples of situations that involve REALLY big numbers?

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 Let's take a look at some numbers

| Exponent  | Write it Out                                                               | Formal Name      |
|-----------|----------------------------------------------------------------------------|------------------|
| $10^0$    | 1                                                                          | One              |
| $10^1$    | 10                                                                         | Ten              |
| $10^2$    | $10 \times 10 = 100$                                                       | one hundred      |
| $10^3$    | $10 \times 10 \times 10 = 1000$                                            | one thousand     |
| $10^4$    | $10 \times 10 \times 10 \times 10$                                         | ten thousand     |
| $10^5$    | $10 \times 10 \times 10 \times 10 \times 10$                               | hundred thousand |
| $10^6$    | $10 \times 10 \times 10 \times 10 \times 10 \times 10$                     | one million      |
| $10^7$    | $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$           | ten million      |
| $10^8$    | $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$ | hundred million  |
| $10^9$    |                                                                            | one billion      |
| $10^{10}$ |                                                                            | ten billion      |
| $10^{11}$ |                                                                            | hundred billion  |
| $10^{12}$ |                                                                            | one trillion     |
| $10^{13}$ |                                                                            | ten trillion     |
| $10^{14}$ |                                                                            | hundred trillion |
| $10^{15}$ |                                                                            | one quadrillion  |

When we multiply by ten what happens?

| Problem              | Work  | Answer | What do you notice?                                      |
|----------------------|-------|--------|----------------------------------------------------------|
| $8 \times 10$        | 8.0   | 80     | move one decimal spot to right for 10 or add a zero      |
| $5 \times 100$       | 5.00  | 500    | move two decimal spots to right for 100 or add two zeros |
| $3.5 \times 10$      | 3.5   | 350    | " one spot one zero                                      |
| $3.5 \times 100$     | 3.5   | 350    | " two spots two zeros "                                  |
| $7.8 \times 1,000$   | 7.8   | 7800   | " three spots three zeros "                              |
| $9.523 \times 100$   | 9.523 | 952.3  | " two spots two zeros "                                  |
| $0.531 \times 100$   | 0.531 | 53.1   | " two spots two zeros "                                  |
| $0.023 \times 1,000$ | 0.023 | 23     | " three spots three zeros "                              |

Can we make things simpler by using a form known as scientific notation?

Now, it's just a multiplication form in shorthand notation...just like texting a really big number with abbreviations.

| Problem              | What it really means     | Answer        | What do you notice?                                                                 |
|----------------------|--------------------------|---------------|-------------------------------------------------------------------------------------|
| $2.3 \times 10^2$    | $2.3 \times 100$         | 230           | I moved the decimal two spots to the RIGHT, since 100 makes the number BIGGER! 😊    |
| $1.52 \times 10^3$   | $1.52 \times 1,000$      | 1,520         | I moved the decimal three spots to the RIGHT, since 1000 makes the number BIGGER! 😊 |
| $2.012 \times 10^4$  | $2.012 \times 10,000$    | 2,0120 20,120 | "four spots<br>four <del>two</del> zeros"                                           |
| $3.000 \times 10^3$  | $3.000 \times 1,000$     | 3,000         | "three spots<br>three zeros"                                                        |
| $2.58 \times 10^5$   | $2.8 \times 100,000$     | 258,000       | "5 spots<br>5 zeros"                                                                |
| $3.92 \times 10^7$   | 3.92 <del>uuuuuuuu</del> | 39,200,000    | "7 spots<br>7 zeros"                                                                |
| $1.0945 \times 10^6$ | 1.0945 <del>uuuuuu</del> | 1,094,500     | "6 spots<br>6 zeros"                                                                |

Now, that we have taken care of positive exponents with a base of 10...what about negative exponents?

| Exponent  | Write it Out | Formal Name            |
|-----------|--------------|------------------------|
| $10^{-1}$ | .1           | One tenth              |
| $10^{-2}$ | .01          | One hundredth          |
| $10^{-3}$ | .001         | one thousandth         |
| $10^{-4}$ | .0001        | one ten thousandth     |
| $10^{-5}$ | .00001       | one hundred thousandth |
| $10^{-6}$ | .000001      | one millionth          |
| $10^{-7}$ | .0000001     | one ten millionth      |

When we multiply a decimal by a number, what happens?

| Problem              | Work                                                 | Answer                            | What do you notice?                                                                                       |
|----------------------|------------------------------------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------|
| $8 \times .1$        | $8 \times \frac{1}{10}$                              | $\frac{8}{10} = .8$               | The decimal moves back one spot to the left because the number is smaller than one. It is like division.  |
| $5 \times .01$       | $5 \times \frac{1}{100}$                             | $\frac{5}{100} = .05$             | The decimal moves back two spots to the left because the number is smaller than one. It is like division. |
| $35 \times .001$     | $35 \times \frac{1}{1000}$                           | $\frac{35}{1000} = .035$          | 3 spots left<br>3 zeros in 1,000                                                                          |
| $3.5 \times .01$     | $3.5 \times \frac{1}{100}$                           | $\frac{3.5}{100} = .035$          | 2 spots left<br>2 zeros in 100                                                                            |
| $7.8 \times .001$    | $7.8 \times \frac{1}{1000}$                          | $\frac{7.8}{1000} = .0078$        | 3 spots left<br>3 zeros in 1000                                                                           |
| $9.523 \times .0001$ | $9.523 \times \frac{1}{10,000}$                      | $\frac{9.523}{10,000} = .0009523$ | 4 spots left<br>4 zeros in 10,000                                                                         |
| $0.531 \times .0001$ | $.531 \times \frac{1}{10,000}$<br><u>    </u><br>531 | $\frac{.531}{10,000} = .0000531$  | 4 spots left<br>4 zeros in 10,000                                                                         |
| $0.023 \times .1$    | $.023 \times \frac{1}{10}$<br><u>  </u><br>0.023     | $\frac{.023}{10} = .0023$         | 1 spot left<br>1 zero in 10                                                                               |

Let's try shorthand notation..instead of those messy decimals! It's like texting a really small number!

| Problem                 | What it really means           | Answer     | What do you notice?                                                                |
|-------------------------|--------------------------------|------------|------------------------------------------------------------------------------------|
| $2.3 \times 10^{-1}$    | $2.3 \times .1$                | .23        | I moved the decimal one spot to the LEFT, since 1/10 makes the number SMALLER! ☺   |
| $1.52 \times 10^{-2}$   | $1.52 \times .01$              | .0152      | I moved the decimal two spots to the LEFT, since 1/100 makes the number SMALLER! ☺ |
| $2.012 \times 10^{-3}$  | $2.012 \times .001$            | .002012    | 3 left exp -3<br>3 zeros in $\frac{1}{1,000}$                                      |
| $3.000 \times 10^{-2}$  | $3.000 \times \frac{1}{100}$   | .003       | 2 left exp -2                                                                      |
| $2.58 \times 10^{-4}$   | $2.58 \times \frac{1}{10,000}$ | .000258    | 4 left exp -4                                                                      |
| $3.92 \times 10^{-3}$   | $3.92 \times .001$             | .00392     | 3 left exp -3                                                                      |
| $1.0945 \times 10^{-5}$ | $1.0945 \times .00001$         | .000010945 | 5 left                                                                             |

Observations: What is the difference between scientific notation with positive powers vs. negative powers?

-discuss in class: come prepared!