Order of Operations HW 2: Square Roots

This homework is going to attack the place that **radicals** play in math. Not radical like those punks at right…radical as in ***roots***[1].

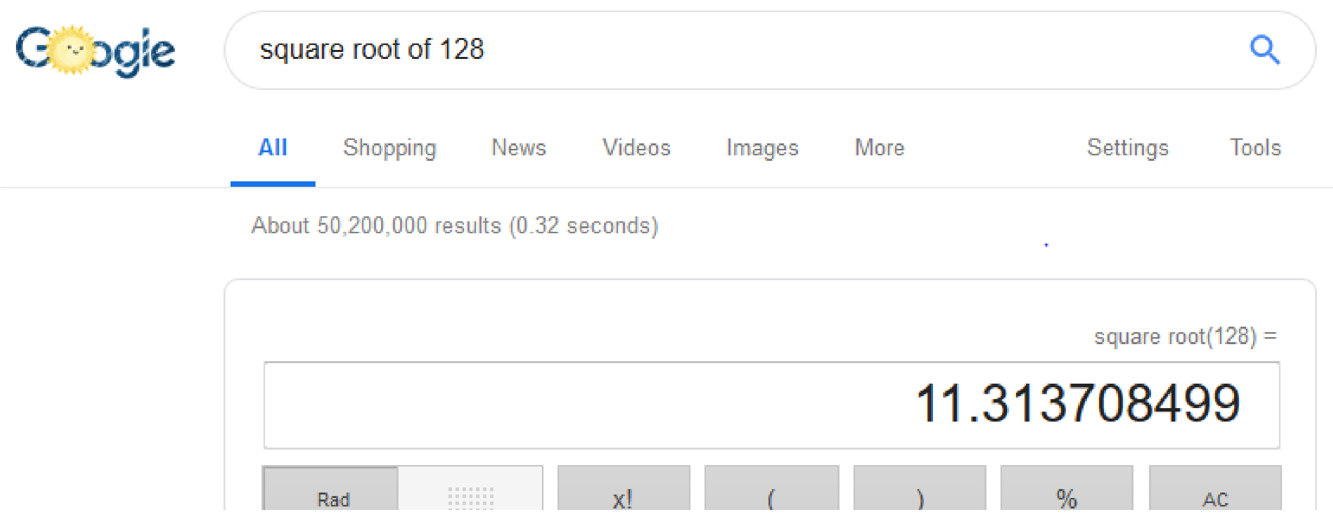
Let's do a brief review of roots to make sure we're on the same page! In the broadest sense, a **root** is an operation that undoes an exponent. So, for example, you all know that $4^2 = 16$. Therefore, the "square root" of 16 would be 4, since it's the notation that undoes the squaring. In symbols, it looks like this!

$$\sqrt{16} = 4$$

Here's another one: if I know that some number squared is 64, what's the number? Well, I just have to take the square root of 64, and if I do, I get 8.

But more often than not, square roots that we have to deal with in real-life situations (like building around the house) are not "nice"—that is, ***whole***—numbers.

For example, what if we want to know the square root of 128? Now, $\mathbf{11^2 = 121}$ and $\mathbf{12^2 = 144}$, so the square root of 128 must be between 11 and 12 (and probably closer to 11). Let's have Google give us a more precise answer:



[1] This sentence will likely confuse anyone who knows who those guys are. ☺

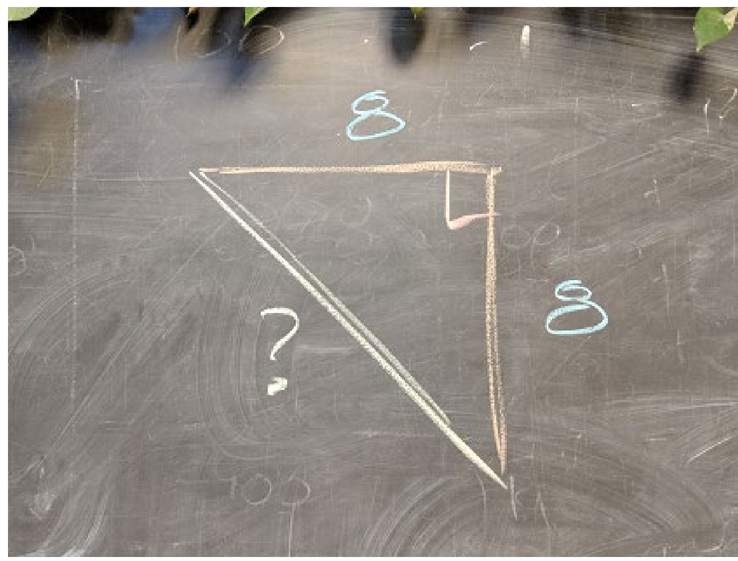
1. **(1 point each)** You try Google to do these next three. Round to the nearest thousandths place.

$\sqrt{\mathbf{38.2}}$ $\sqrt{\mathbf{153}}$ $\sqrt{\mathbf{0.3}}$

Now, square roots aren't the ***only*** roots you'll ever come across; there are cube, 4^{th}, 5^{th}, …, even 30^{th} roots (you'll probably look at roots like these in MTH 105). But square roots are the most commonly used.

For now, the big idea is to make sure that you understand where roots live in the "order of operations" world.

We'll go back to the example I gave you before: $\sqrt{\mathbf{128}}$. I want to show you where that number came from! At right is a rough diagram of the type you can use to help build shelves and other thing that involve right (90 degree) angles. The top horizontal line, marked with an 8, represents the length of the shelf itself, and the vertical 8 length is the part of the shelf that will sit along the wall (don't worry about the units right now; we'll deal with them later). The diagonal (marked with the "?") is the length of the support you'd need to cut to keep the shelf stable.



You'll learn about something called the **Pythagorean Theorem** later in this course. Don't worry if you don't know it (or have forgotten it) right now. 😊

To figure out the value of the **?**, you need to evaluate the following expression:

$$\sqrt{\mathbf{8^2 + 8^2}}$$

2. **(2 points)** Now, this quantity needs to equal about **11.3** (remember, that's the decimal version of $\sqrt{\mathbf{128}}$ that Google gave us). Which of the following will achieve that? Pick the correct one! If you're not sure, follow each set of instructions and see which gives the answer we're looking for.

Squaring the 8's first, then taking the square root of each of those 64's, and then adding the results together.

Canceling the exponents of 2 with the square root, and adding the two 8's together.

Squaring the 8's first, then adding those two results together. Last thing you would do would be to take the square root of the number that's left.

So, what we just learned is that we need to add a little to our order of operations. I've added the new stuff in **orange**.

Order of Operations (*final revision*)

- **(*First*!) If there are any *Parentheses*, do all the math inside them first**.

NOTE: Big fractions' numerators and denominators "count" as parentheses, **and so do expressions under roots.**

$$\text{Ex. } \frac{8 + 13 + 21}{3} = (8 + 13 + 21) \div 3$$

$$\text{Ex. } \sqrt{3^2 + 4^2} = \sqrt{(3^2 + 4^2)}$$

- **(*Second*!) If there are any *Exponents*, take care of them next.**
- **(*Third*!) Do any *Multiplications* (or *Divisions*) that are left.**
- **(*Fourth*!) Then do any *Additions* (or *Subtractions*).**

(**1 point each**) Try a couple for practice now. You can use technology to help with the arithmetic. Again, round each answer to the nearest thousandths place.

3. $\sqrt{32.3^2 + 19.4^2}$

4. $\sqrt{5^2 + 6^2 + 7^2}$

Now, look back to the first example (the one with the shelf). Suppose the units on those "8"'s are ***inches***.

5. (**1 point**) What unit must be on the "**11.3**"?

6. (**2 points**) Hang on – I thought we ***squared*** those inches! Where did the "inches squared" go?

7. **(1 extra point)** You might notice that, in every example you did today, the number under the square root symbol was always larger than the square root of that number…except for the square root of 0.3. Why is the square root of 0.3 larger than 0.3 itself?