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Hello and welcome to the 4th episode of Chemistry the study of change.

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Previously in chemistry the study of change...

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We learned about several units used in the international system, or SI.

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We learned to use metric prefixes to derive valid conversion factors.

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And we learn to calculate area and volume relationships from linear conversion factors.

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In today's episode...

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We will use the density formula to calculate density, mass or volume.

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We will learn to use scientific notation and to convert numbers between standard and scientific notation.

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And we will learn to do simple arithmetic using numbers in scientific notation.

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Our last episode ended with a question about the number of square inches in a square yard.

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From your conversion table.

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You find that there are 12 inches in 1 foot.

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And that there are three feet in one yard.

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Taking it a step further, that means that there are 36 inches in one yard and that is the conversion factor we will use.

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So now we can square the conversion factor.

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Whip out our calculator and conclude that there are 1296 square inches in a square yard.

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Onto the new stuff.

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Density is defined as the ratio of a sample or object's mass to its volume.

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It can be measured by using a combination of mass and volume units.

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The density formula is simply mass divided by volume.

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And it can be abbreviated as.

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d is equal to m over V.

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This formula could also be rearranged to solve for mass.

00:03:04

Like so.

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It can be further rearranged.

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To solve for volume.

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You may remember that density is an intensive property and can be used to help identify a substance.

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This list has the densities of some common substances.

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Interesting fun fact.

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Objects having densities lower than the density of a fluid will float on it.

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Those having densities higher than the fluid will sink in it.

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That means that if someone.

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Tells you your head's in the clouds, they are not being very kind at all.

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Let's consider a certain gold sample (who doesn't like gold?)

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If this ingot has a mass of 301 grams.

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And a volume of 15.6 cubic centimeters.

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What is its density?

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We will consider the density formula.

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Because the question is about density, there is no need to rearrange the equation.

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We simply plug in our given quantities.

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Whip out our calculator.

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And we get 19.29 grams per cubic centimeter.

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Which, by the way, it's what it expected of a gold sample.

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It's always a good feeling to know that we are not getting ripped off.

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Let's now consider a sample of mercury whose density and volume we know.

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Because the question is above the mass.

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We will have to rearrange our density formula.

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In order to solve for mass.

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We then substitute the density and the volume.

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Cancel those milliliters.

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And whip out our calculator to get 74.8 grams.

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You may notice that in chemistry,

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When we do math, we always mind the units.

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This is important, and they must be written.

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It is also important that the units that are in excess

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Of your requirements, be cancelled.

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We wanted a mass and we expected to have a unit of grams.

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The fact that we did get it reassures us that we did not make a mistake.

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So now and always pay attention to the units.

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Because the stars might lie...

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But the units never do.

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We will now consider an alternative way of writing numbers called scientific notation.

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Scientific notation is at its most practical when it is used to express very large numbers.

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Or when it is used to express very small numbers.

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Because in both cases it saves us a lot of writing.

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However, any number can be expressed in scientific notation, whether it is practical or not.

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There are two parts to a number expressed in scientific notation.

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The pre-exponential factor which is always between one and 10 but does not include 10.

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And an integer which is a power of 10.

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To write a number in scientific notation, you will have to move the decimal so that it is directly behind the first non-zero digit.

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When you move the decimal, you must raise or lower.

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The power of 10 by the number of places you move the decimal.

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So, if you moved it left two places, the power of 10 goes up by two.

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But if you must move the decimal to the right,

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Then you must lower the power of 10 by the number of places you move the decimal.

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So in this example it goes down to negative 6 because it was moved six places.

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To the right.

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Up and left.

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Or right and down.

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To do addition and subtraction.

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With numbers in scientific notation, we have to follow some simple rules.

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First, make sure that both quantities have the same exponent.

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If they don't change one so that both have the larger exponent.

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After that, either add or subtract (depending on what you're doing).

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The pre-exponential factors.

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And give the answer the same exponent.

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As the two addends.

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For example.

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We rewrite in this case 3.9 times 10 to the 3rd, so that its exponent becomes 4.

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And then we combine the 4.31.

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And the 0.39.

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For multiplication:

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We will multiply the pre-exponential factors.

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And we will add.

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The exponents.

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So in this example we will multiply 7 times 4.

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And we will add -5 and 3.

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This will give us 28 times 10 to the -2.

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That's our answer, but we notice that the decimal is not where it should be.

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We next move the decimal one place to the left, so it is where it belongs.

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And bring up the exponent to -1.

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And that is our final answer.

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For division, we will divide the pre-exponential factors.

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And we will subtract the exponents.

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So in this example.

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We will divide 8.5 by 5.

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We will subtract 4 - 9.

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This gives us 1.7 times 10 to the -5.

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This is our final answer because the decimal happens to be where it belongs.

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Well, it is now time to get some practice.

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Let's rewrite each of the numbers in the first column.

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To scientific notation.

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And then carry out the arithmetic problems on the second column.

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Please pause the video and write down your answers.

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Then come back and we will check how you did.

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Welcome back, let's take a look first at that first column.

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First example, we move the decimal 2 places to the left and raise the power from zero to two.

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Here we did not move the decimal at all, so the power of 10 stayed at 0.

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Here we move the decimal 4 places to the right, so the power of 10 went down to negative 4.

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Here we move the decimal 2 places to the left, so the power 10 went up to two.

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Here, once again we did not move the decimal, so the power 10 remains at 0.

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Here we move the decimal 2 places to the left, so the power 10 went up to two.

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Here we move the decimal 3 places to the right.

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So the power 10 went down to negative 3.

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And finally, here we move the decimal 3 places to the left.

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And our power of 10 went up to three.

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Well, next, let's take a look at that second column.

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For the first example, we first rewrite the problem so that the two quantities have an exponent of four.

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We then combine them.

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And our final answer is 2.15.

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Times 10 to the 4th.

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For the next example.

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We will multiply the pre-exponential factors.

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And add the exponents.

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Like so.

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That gives us a final answer of 7.8 times 10 to the 11th.

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For the next example, we will divide the pre- exponential factor and subtract the exponents.

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Just like this.

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To get 3 times 10 to the negative 10.

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And finally, for our last example.

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We must rewrite the quantities so they both have an exponent of negative 2.

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We next subtract the pre-exponential factors.

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And our final answer is.

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1.28 times 10 to the negative 2.

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Your calculator also understands scientific notation, and it can actually do a lot of the arithmetic for you.

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But this requires that you follow its rules.

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So it doesn't get confused.

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Your calculator will have an EXP button.

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But it also goes by other names.

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Here is the button I speak of.

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In different calculators it can be found in different places and also under different names.

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Like EE

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Or times 10 to the X.

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An important side note, some calculators have a 10 to the X key.

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10 to the X and times 10 to the X are not the same.

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It must have a times 10 to the X to be the button you seek.

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This EXP button is also found sometimes.

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As a second function, like here.

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Whatever it's called and wherever it's placed,

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The way to enter a number in scientific notation into your calculator is as follows.

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Let's say we want to type in 2.34 * 10 to the negative 12.

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First you type the pre-exponential factor.

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In normal fashion 2.134.

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Then you press the EXP button or the EE or the times 10 to the X.

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Whatever key your calculator has.

00:19:26

And then you enter the power of 10.

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Negative 12

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Another important side note.

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The negative key in your calculator is not the same as the minus key.

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Notice that it is usually placed in parentheses or it will be a plus slash minus.

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Those two keys are the same.

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Note that the 10 or the times is not typed in anywhere.

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If you type it in, you will confuse your calculator because it is not expecting it.

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Now to test your calculator.

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Let's try this.

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Type this in your calculator and then hit enter.

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If the answer is not two00:20:35

Come by using the office hours link and we will get it sorted out because you will be using this key quite a lot in the coming units.

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And that's all there is.

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There isn't anymore.