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Hello, and welcome to the 7th and final episode of Chemistry, the study of change.

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Previously in chemistry the study of change.

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We introduced the dimensional analysis method for problem solving.

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In today's episode.

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We will sharpen our dimensional analysis skills.

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We will practice using diagrams to determine which conversion factors to use.

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And we will learn why temperature conversions are different from any other type of conversions.

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Oh, and we will practice making temperature conversions.

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You should print the PDF file dimensional analysis problems.

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This video will show you how to work these problems step by step.

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Work out the problems beforehand, watching the rest of the video later.

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Or if you prefer, watch the video now and then solve the problems.

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Whatever works for you.

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Our first example problem.

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The given is 0.324 pints.

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And the ask is how many microliters?

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We'll be starting our diagram with these two units at either end.

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We look for a direct conversion factor, but we don't find one.

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So now we look for any conversion factor having microliters or pints.

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Because microliters is an SI unit we can convert to liters using the prefix micro and its meaning.

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So that is one of the conversion factors we write down.

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Connecting liters and microliters.

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We also have conversion factors between liters and quarts and between liters and cubic feet.

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At this point we don't know which is going to work, so we are going to keep our options open.

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We notice that there is a conversion factor between pints and quarts.

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So that makes quarts our better option.

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Now we have to draw the frames to fit the given plus three conversion factors.

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As we have 3 arrows in our diagram.

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We place our given quantity in the 1st frame.

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And the conversion factor between pints and quarts in the 2nd frame.

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Making sure that the unit pints cancels.

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We now place the conversion factor between liters and quarts in the 3rd frame.

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And we make sure that the unit of quartz cancels.

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We then place the conversion factor between liters and microliters in the last frame.

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Making sure that the unit liters cancels.

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We now look at the significant digits.

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And we see that the quantity with the least number of significant digits has three.

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And so we make sure that our final answer is rounded, so it has three significant digits as well.

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Our next problem has a given of 40 mph.

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And an ask of how many feet per second?

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We will need two separate diagrams.

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One between miles and feet and one between hours and seconds.

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Our conversion tables do have a direct conversion between miles and feet.

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So that's that.

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We don't have a conversion factor for time.

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We probably know that there are 60 minutes in one hour.

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And 60 seconds in one minute.

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So those will serve as our conversion factors.

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We see now that we will need enough frames for the given.

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And three conversion factors.

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On the 1st frame we place our given.

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Notice that part of the unit goes in the lower frame.

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Our first conversion factor goes in the 2nd frame.

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And we make sure that the unit miles cancels.

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The second conversion factor goes in the 3rd frame.

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And we make sure that the unit of hours cancels.

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The third conversion factor goes in the last frame.

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And we make sure that the unit minutes cancels.

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Now look at the significant digits.

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We determined that the least number of significant digits is 3.

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And so we record our answer to three significant digits.

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Our next problem has a given of 3.42 seconds.

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And an ask of how many feet?

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There is another quantity in this problem, 112 kilometers per hour.

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That is actually one of our conversion factors that we will be using in order to solve this problem.

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We will have to fit it in our diagram.

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A side note.

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Many times, quantities with compound units can be used as conversion factors.

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You may interpret 112 kilometers per hour as 112 kilometers is equal to 1 hour.

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We begin our diagram with a given and the ask at opposite ends a00:09:08

And we seek a conversion factor between kilometers.

s always.

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And then we place our freebie conversion factor.

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Between them

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Notice that the hour points towards the time and the kilometers towards the distance unit.

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The second to hour path.

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Is going to be the same as in our last problem, so we have seconds to minutes and minutes to hours.

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And we seek a conversion factor between kilometers and feet.

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We find a conversion factor between kilometers and miles.

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And another between miles and feet.

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Now we just need enough frames for the given and five conversion factors.

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We place the given in the 1st frame.

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And our first conversion factor in the 2nd frame.

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Making sure that the unit seconds cancels.

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We place the next conversion factor in the 3rd frame.

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Making sure that the unit minutes cancels.

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We place the next conversion factor in the 4th frame.

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Making sure that the unit hours cancels.

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The next conversion factor goes in the 5th frame.

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And we make sure that the unit kilometers cancels.

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Our last conversion factor is placed in the only frame left.

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And we make sure that the unit miles cancels.

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We next determine the number of significant digits of each quantity we used.

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And of course of each conversion factor.

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We conclude.

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That the final answer must have three significant digits.

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And there it is.

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Our next problem has a lot of information.

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We need to find the given and the ask to begin our diagram.

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The ask is the cost in pennies, that one is easy enough to find.

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The given is micrograms of potassium.

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We are also given two conversion factors.

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3 pounds of bananas is equal to $1.00.

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And 200 grams of bananas is equal to 422 milligrams of potassium.

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We begin by placing the given and the ask in opposite ends of the diagram.

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We then place our freebie conversion factors

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One of them were the milligrams of potassium pointing towards micrograms of potassium.

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And the other with the dollars pointing towards the pennies.

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Both micrograms of potassium and milligrams of potassium are SI units.

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So we can look up the prefixes for conversion factors.

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The prefix micro can be used to obtain a conversion factor between micrograms and grams.

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And the prefix milli can be used to obtain a conversion factor between milligrams and grams.

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We then find a conversion factor between grams and pounds.

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To convert grams of bananas to pounds of bananas.

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And finally, we use $1.00 is equal to 100 cents to finish up.

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Oooh, Looks like we're going to need a bigger frame set.

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Now we process as usual.

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1st frame for the given.

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And each of the subsequent frames gets a conversion feature.

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Making sure that the previous unit castles.

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And are placed in exactly the same order that the diagram shows.

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And we make sure again that the previous unit cancels every time.

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With each conversion factor getting closer and closer to the desired unit.

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Almost there.

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Just a couple more.

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You can see the end from here.

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And we're home.

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Now, we check for significant digits.

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And determine that our answer should have three significant digits.

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Since that is the least.

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Number of significant digits.

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We whip out our calculator.

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And we get 11.3 cents.

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What a bargain.

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Notice that

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The diagram helps us make sense of our units and gives us an idea of what goes where and when each conversion factor is to be used.

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This ordering process is very important to the problem solving, otherwise the problem looks overwhelming.

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We can see that it really shouldn't be so, as long as we know how to diagram.

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Our last example.

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Has a bit of astronomy in it.

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It also makes telling the given quantity from the conversion factors.

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A tad, shall we say, challenging.

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It's a lot easier, actually, to determine which are conversion factors than what the given quantity is.

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The speed of light, for instance, has compound units, so it can be a conversion factor.

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The earth’s diameter is a conversion factor. One earth is equal to 7926 miles.

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And that leaves.

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8.52 minutes as the given.

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“How many earth’s?” is the ask.

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So we first place those two at opposite ends of the diagram.

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And then we proceed to place our freebee conversion factors in place.

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One of them is going to connect directly to our ask, One Earth.

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Is equal to 7926 miles

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The other we place with the seconds pointing towards minutes.

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And we can use the one minute is equal to 60 seconds conversion factor to close that gap. That still leaves us one gap.

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And 1.609 kilometers is equal to 1 mile. We'll close that one.00:18:03

Next we draw 5 frames.

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One for the given and four conversion factors.

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Our given goes in the 1st frame.

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And then our conversion factors will fill the remaining frames.

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Making sure that the previous unit always gets cancelled.

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And that all conversion factors go in the same order as the diagram has them.

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And done.

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We determined the number of significant digits of each conversion factor.

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And here I admit that I could not find the number of significant digits for the speed of light, but I will assume it is at least three.

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And that is going to mean that 12,000 Earths fit between the sun and the earth.

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We are using 3.

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We're using three significant digits because that is the lesser number of significant digits that we are given.

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Notice that in this case it is absolutely essential to write the answer in scientific notation in order to show three significant digits.

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Otherwise it will only show 2.

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Which would be unfortunate.

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And now temperatures.

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There are three commonly used temperature scales.

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The Kelvin, Celsius, and Fahrenheit scales.

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Unlike length, volume, mass and any other measurable quantity, when it comes to temperature.

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The scales do not actually begin at the same place.

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What I mean by that is 0.

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Does not mean none in temperature.

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Zero volume means no volume, so 0 liters is equal to 0 milliliters.

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It's equal to 0 cubic meters and 0 whatever unit you wish to use.

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That will be true for other measurements except for temperature.

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The temperature scales have of different starting points.

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And they require a formula rather than a conversion factor.

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We're going to 1st compare the Kelvin and Celsius scales.

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We will focus on water.

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Notice that the water is referenced in all three temperature scales in this diagram.

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And we will be using the freezing point of water and the boiling point of water as our reference points.

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OK.

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Using water as a reference, the normal boiling temperature.

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Is 373 Kelvin and the normal freezing temperature.

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Is 273 Kelvin.

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That's a difference of 100 Kelvin.

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For the Celsius scale, the normal boiling temperature is 100 degrees Celsius.

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And the normal freezing temperature.

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It's zero degrees Celsius.

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That's a difference of 100 degrees Celsius.

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That means that Kelvin and Celsius and degree Celsius are exactly the same size, and the only thing you need to convert between the scales is to shift their starting point.

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So to convert Kelvin.

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We add 273.15 to the Celsius temperature.

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And to convert to Celsius we subtract 273.15 from the Kelvin temperature.

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Now let's compare the Celsius and Fahrenheit scales using once again water as a reference.

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The normal boiling temperature.

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Is 212 Fahrenheit.

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And the normal freezing temperature is 32 degrees Fahrenheit.

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A difference of 180 degrees Fahrenheit.

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That means that Fahrenheit and Celsius degrees have different size, and the scales have different starting points.

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To compare it between them, you must do a shift.

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And also use a conversion factor.

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Notice that the Fahrenheit scale starts 32 degrees below the Celsius scale.

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Not shown here.

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It's another factor that is important.

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The Fahrenheit and Celsius scales.

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Have the same value a negative 40 degrees.

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Negative 40 degrees Celsius is equal to negative 40 degrees Fahrenheit.

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That's why the following formula works.

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To convert to degrees Fahrenheit, we 1st add 40 to the Celsius temperature to shift it.

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Multiply by 9 fifths, which is our conversion factor and then subtract 40 to shift it back.

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To convert to degrees Celsius we add 40 to the Fahrenheit temperature.

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Multiply by 5 ninths.

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And subtract 40.

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There is another formula I should let you know and it also works.

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They will give you the same answer. If you already have it memorized.

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Go ahead and use it.

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It's safe, this one is just a little easier to remember.

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Let's now practice using these formulas.

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Pause the video and carry out each of these conversions.

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Welcome back.

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Let's now check your answers.

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If one or more of your answers did not work out.

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You know where to find me.

00:25:32

Follow the office hour link or the enhanced discussion link and meet me there.

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Because that's all there is.

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There isn't anymore.