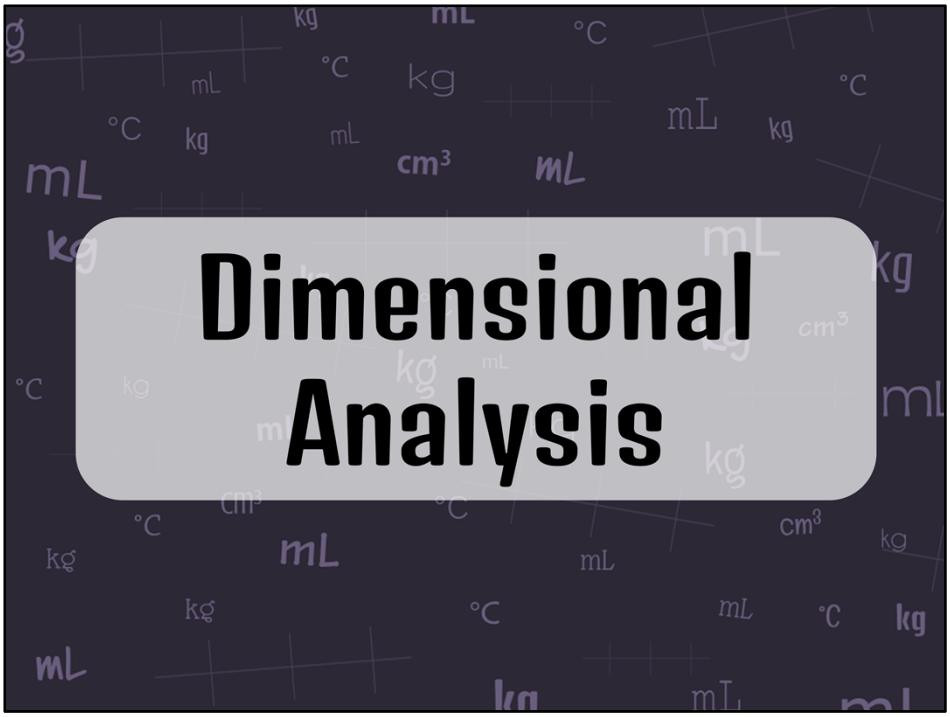
Module 1: What is Chemistry?
Topic 5 Content: Dimensional Analysis Presentation Notes



Dimensional Analysis

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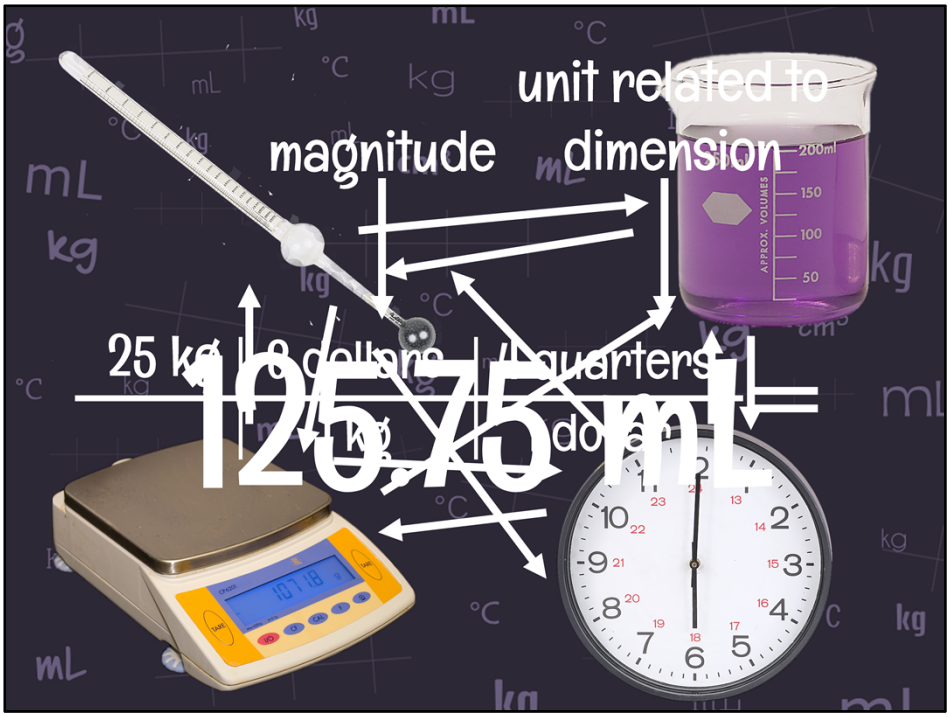

Chemistry involves many measurements. Sometimes, it is important to be able to convert these measurements from one unit to another. Each measurement has two parts – a magnitude and a dimension. Dimensional analysis uses a bracket with a series of equivalence statements to convert between units of measurement. Using dimensional analysis, one unit can be changed into another with an equivalent magnitude with a different dimension. How do chemists complete these conversions?

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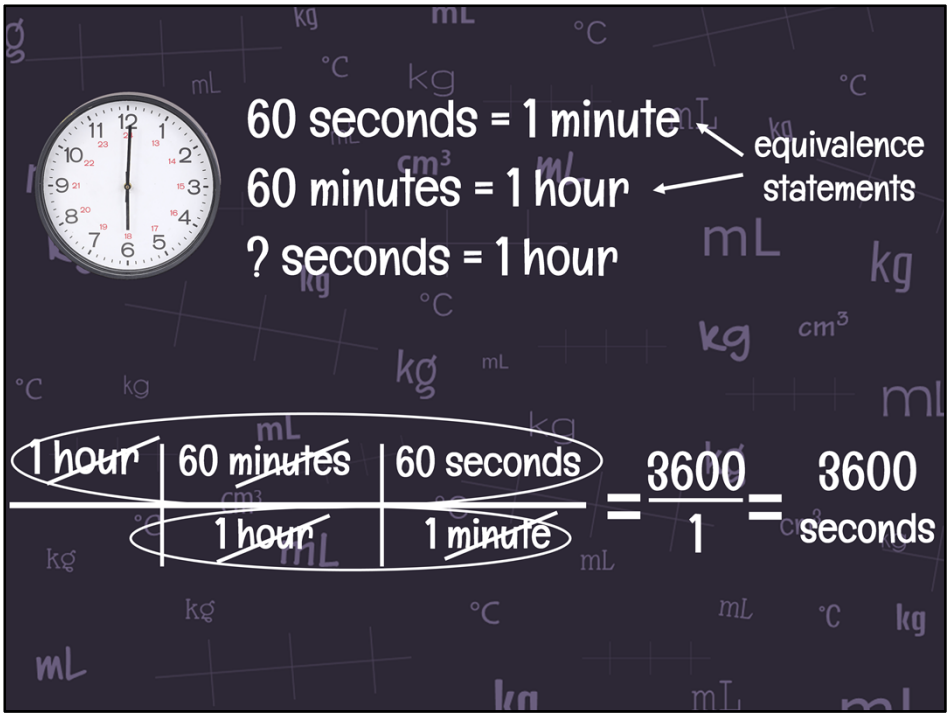

Here is a simple example of using dimensional analysis to convert units. You probably know that there are sixty seconds within a minute and that there are sixty minutes in an hour. These equivalent relationships between units of measurement are called equivalence statements.

What if someone asked you how many seconds are in an hour? How would you calculate the answer? You can use dimensional analysis to find the answer quickly and accurately.

- First, write down your initial quantity or the quantity that you know. In this case, you know that you are trying to find the number of seconds in one hour.
- Next, since you know that there are sixty minutes in one hour, you can add that equivalence relationship to the diagram.
- Now, since you know that there are sixty seconds in one minute, you can add that equivalence relationship to the diagram. Since seconds is the dimension that you are trying to find, you can stop adding conversion factors to the diagram.
- Next, you will need to cancel the unwanted units. Any units that are repeated in the numerator and the denominator of the diagram can be crossed out.
- Finally, you will multiply the magnitudes on the top, and then multiply the magnitudes on the bottom. Then, you will divide the answer's numerator by its denominator. In this instance, you find that there are 3,600 seconds in one hour. You will need to make sure that your calculations use the correct number of significant figures.

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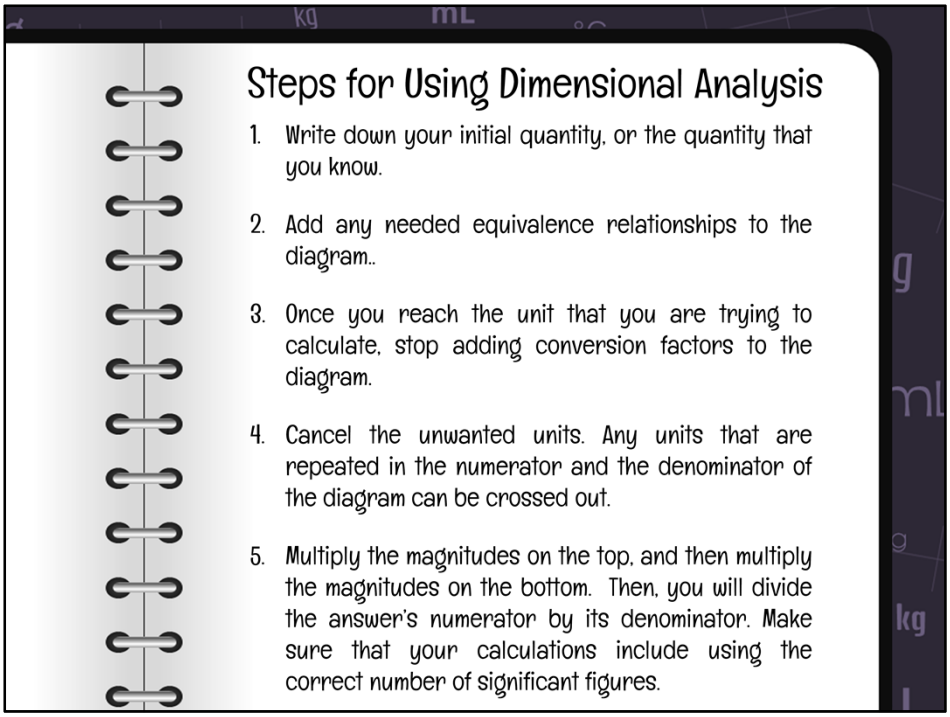

Before you move on, here is a review of the steps to convert from one unit to another using dimensional analysis:

1. First, write down your initial quantity or the quantity that you know.
2. Next, add any needed equivalence relationships to the diagram.
3. Once you reach the unit that you are trying to calculate, stop adding conversion factors to the diagram.
4. Cancel the unwanted units. Any units that are repeated in the numerator and the denominator of the diagram can be crossed out.
5. Multiply the magnitudes on the top, and then multiply the magnitudes on the bottom. Then, you will divide the answer's numerator by its denominator. Make sure that your calculations include using the correct number of significant figures.

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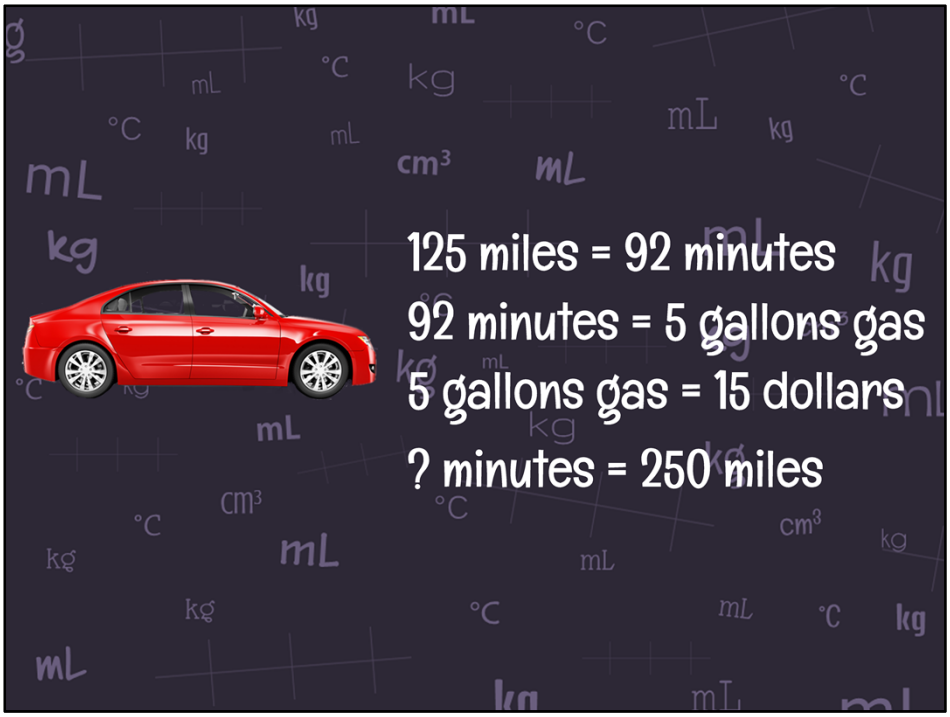

Now, take a look at another example of dimensional analysis. Pretend that you and a friend are going on a road trip. For this trip, you already know that you will be traveling 125 miles, which will take you 92 minutes, using 5 gallons of gas, which cost you $15.00. Now, pretend that your friend wants to travel to a destination that is 250 miles. You know that you will need to let your parent or guardian know when you will be back, so you need to calculate the time that this trip will take.

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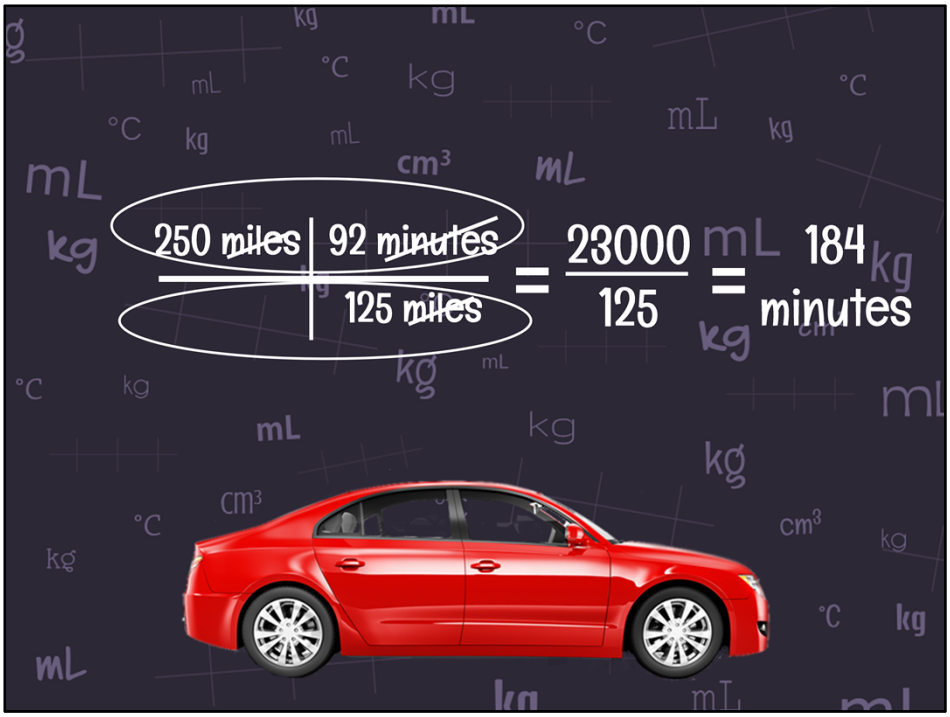

You can calculate this amount using dimensional analysis. Since you know that you want to travel 250 miles, that is the quantity that you place in your bracket first. You also know that you can travel 125 miles in 92 minutes, so you will need to add that as your equivalence statement. Since you are ultimately looking to find out how long your 250 mile trip will last, you can stop here. Now, you need to cancel out the unwanted units. Next, you multiply the quantities in the numerator and the quantities in the denominator. Since you have a fraction, divide the final fraction. Here you can see that your 250 mile road trip will take you 184 minutes.

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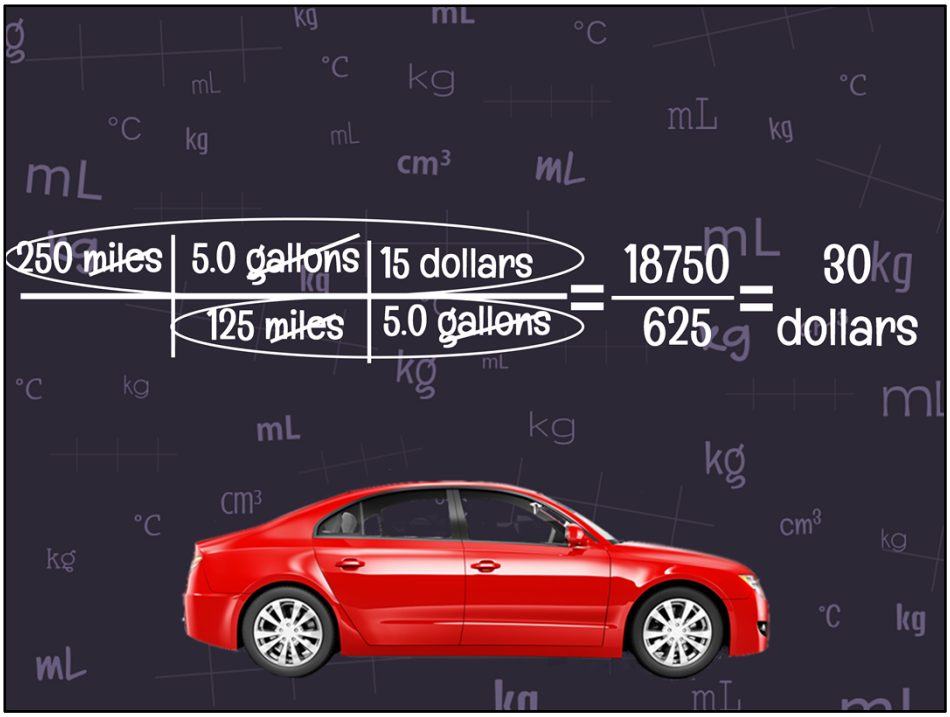

Now, take this example one step further. You also need to know how much this longer trip will cost you so that you have enough money for gas. Since you know that you want to travel 250 miles, that is the quantity that you place in your bracket first. You also know that you can travel 125 miles on 5.0 gallons of gas, so you will need to add that as your first equivalence statement. You also know that 5.0 gallons of gas costs you $15.00, so you add that equivalence statement, too. Since you are ultimately looking to find out how much your 250 mile trip will cost you, you can stop here. Now, you need to cancel out the unwanted units. Next, you multiply the quantities in the numerator and the quantities in the denominator. Since you have a fraction, divide the final fraction. Here you can see that your 250 mile road trip will cost you $30.00.

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You will use dimensional analysis throughout your study of chemistry to calculate conversions between units of measurement. It is an important problem-solving skill that allows you to break down complicated calculations into simpler conversion factors. Can you think of uses of dimensional analysis in everyday life?