# CHEMICAL ANALYSIS - AP CHEM 002

**[Chemical Analysis](http://www.bozemanscience.com/ap-chem-002-chemical-analysis)- YouTube Link**
**http://www.bozemanscience.com/ap-chem-002-chemical-analysis**

Slide 1 (00:00-00:56)

Hi. It's Mr. Andersen and this is chemistry essentials video 2. It's on chemical analysis. One of the first early chemists, Jons Jacob Berzelius, who was Swedish, came up with a way that we write out chemical formulas. And I love this picture here. It's one of those where no matter where I move, he seems to be watching me. But, so when we write out CH2O, which is actually going to be the empirical formula or the simplest formula of a sugar, let's say glucose, we owe it to him for that. But if we look at the actual structure, this is what glucose looks like. So it's going to have 6 carbon, 12 hydrogen and 6 oxygen. But chemical analysis is simply looking at a compound, like glucose for example, figuring out what's in there, how much of that what and then how it's all connected together.

Slide 2 (00:57-01:26)

And so in chemical analysis we're looking at compounds. And remember compounds are going to be made up of atoms. And each of those atoms have a specific mass. And so what we can do is look at the percent mass. In other words how much of that mass of that compound is made up by each of those different atoms. That tells us what the composition is. It also can help us figure out the empirical formula. That's that simplest chemical formula. And it also can be used to test the purity of a substance. In other words is it just that or are there other things that are added inside there.

Slide 3 (01:27-01:52)

And so let me give you an example. And we'll come back to this at the end of the video. Let say we take vitamin C and we put it in a mass spectrometer, which is going to tell us the percent mass of all of the atoms that are found inside it. And then we get this spit out. So we've got carbon, hydrogen and oxygen. And it tells us the percent mass of each. In other words it tells us how many grams are going to be made up of each. Could we figure out the empirical formula? Well, we will. We're going to get back to that in just a second.

Slide 4 (01:53-02:21)

And so let me use analogy to begin with. So just like matter is made up of atoms, we could talk about something like a big Lego structure being made up of Legos. And so let's say we had this base unit and it weighed 2.5 grams. It doesn't matter if we have a larger or even a larger unit made up of those smaller blocks. It's all going to have the same average mass. In other words is we divide by the number of bricks, we're still going to have an average mass. No matter how big the sample of those Legos is.

Slide 5 (02:22-02:53)

But now let's get to solving it the other way. In other words if I give you a big structure that weighed 320 grams, could you work backwards to figure out how many bricks are in that structure? Well you would use factor-label to figure that out. In other words, if each brick weighs 2.50 grams I can write it out like this. Now we can cancel off those grams. And so what I get is 128 bricks in that structure. And so what we can do is we can work backwards from that mass and we can figure how much stuff is inside there.

Slide 6 (02:54-03:51)

Now when we're working with chemistry we don't deal with bricks. What we're going to work with is something called a mole. And so let me use gold as an example. Let's say I had 1 mole of gold. Or 4 or 32. It's all going to be the same mass. And what is a mole? I'll talk more about that in the next video. It's essentially a usable amount of an element. A usable amount of a compound. And so all of these are going to have the same average mass. 197 grams per mole.

Now where am I getting that 197? Just like 1 Lego piece weighs about 2.50 grams, 1 mole is going to weigh around 197 grams. And so where do we find that? On the periodic table. And you should get used to just opening up that periodic table. And so if we look at gold, its atomic mass number is going to be around 197. In other words it's 197 atomic mass units or if we have one mole of it, it's going to be 197 grams. So it's going to have the same average mass.

Slide 7 (03:52-04:16)

And so what we can do is we can convert to moles. We can, just like we converted to bricks, we can convert to moles. And let's say I have a 2 ounce chunk of gold, which is around 56.7 grams. And so what I could do is since I know that 1 mole is going to be 197 grams, I could cancel off those grams again. What I could come up with is about 0.288 mole. And so a mole is going to tell us how much of that element is going to be found.

Slide 8 (04:17-04:28)

So let's go back to that problem again. Let's say we're given some vitamin C. We put it in a mass spec and we get this data out of it. What is that telling us? It's telling us the percent of each of those inside there.

Slide 9 (04:29-05:16)

And so what we could do, let's throw that data out here, is we can convert it to moles. And once we have it in moles, we could figure out the empirical formula. So just like we did with the gold, how do we convert this to moles? Well we'd have to get out the periodic table.

And so since carbon has an atomic mass of 12.01, we could write out this conversion. We're going to cancel off the grams of carbon and it would be 5.11 moles of carbon. Likewise if we were to convert the hydrogen, again it's going to have a different atomic mass number. We could convert those grams of hydrogen. And it would be 6.80 moles. So that doesn't tell us much yet. Let's go to oxygen. Oxygen's atomic mass remember is 16. So I could cancel this off. And now we get 5.11 moles. Well that's weird that these are the exact same. Not really. It's just our first piece of evidence that there's the same amount of carbon as there is oxygen.

Slide 10 (05:17-05:56)

Let's simplify that a little bit. So since we divide them each by 5.11, we get 1 of the carbon to 1 of the oxygen to 1.33 of the hydrogen. Now should we write it out like that? You've never seen a chemical formula written with anything aside from whole numbers down here. And so what we could do is multiple the whole thing times three and now we get the empirical formula of vitamin C. Or ascorbic acid.

Now is that really what it looks like? No. And we'll get to that later. This is what it looks like. So it's actually going to have 6 carbons. It's going to have 8 hydrogens. And it's going to have 6 oxygens. But you can see how we can use the mass to figure out what's in there. And then how much of that what is going to be found in there as well.

Slide 11 (05:57-06:12)

We could also use a mass spec to figure out the purity. So if we were to throw that vitamin C in there and we get kind of evidence like this. Well that tells us there's a lot of carbon, hydrogen and oxygen. But we also have some impurities in there. We have some mercury and palladium which is something that you don't want in your vitamins as well.

Slide 12 &13 (06:13-06:41)

So could you fill out this concept map?  Could you fill out the spaces?  Could you pause the video right here.  Okay let's go through it.  Chemical analysis is used on compounds, which are made of atoms.  Which each of those atoms have a specific mass.  Remember we can therefore use the mass percent to figure out the composition.  In other words what is in the compound.  We could use that to figure out the empirical formula which is the simplest whole number formula.  And then we could also use that to figure out the purity of that substance.

Slide 14 (06:42-07:23)

And so did you learn the following?  This is what I was hoping you would learn.  Number one, you could use mass data to identify or infer the composition of pure substances and/or mixtures.  So again we just look at the mass percent of everything that's inside there.  And then the second thing.  Could you use mass data in order to justify a claim regarding the identity or estimated purity of a substance?  And so those are the two things that you should be able to do.  We learned how to figure out the empirical formula.  And I hope that was helpful.