Chem1311Ch2Ep2 1.mp4

Transcript

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Hello, and welcome to the second episode of atoms, molecules and ions.

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Previously in atoms, molecules and ions.

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We learned to determine the number of each subatomic particle in a given isotope.

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We learned to distinguish metals from nonmetals using the periodic table.

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And we learned a difference in the behavior of metals and nonmetals when it comes to forming ions.

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And we learned to distinguish between ionic and molecular compounds.

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In today's episode:

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We will learn the difference between an empirical and a molecular formula.

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And we will learn to both name and determine the formula of ionic compounds.

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Let's start with the basics of ionic compounds.

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Monatomic ions consist of a single charged atom.

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Sodium, chloride, calcium, oxide, aluminum, and nitride are all examples.

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Notice two things, all the metals form cations, which are positively charged.

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Whereas the nonmetals form anions, which are negatively charged.

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Second thing

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All the anions take on an “-ide” ending.

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A polyatomic ion contains 2 or more atoms.

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Hydroxide, cyanide, Ammonium and nitrate are all examples.

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Your reference materials include a table of common ions.

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If you look through them, you will notice that there are three acceptable endings for anions.

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The “-ide” ending we have talked about already.

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The “-ate” ending.

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And the “-ite” ending.

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Ionic compounds consist of a combination of cations and anions in an orderly 3-dimensional matrix called a crystal.

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Here we have sodium chloride as an example.

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Let's focus on the open cage model all the way to the left.

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Look at that central sodium ion.

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This one.

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(I am highlighting it with a green Oval)

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Notice that above and below are chloride ions.

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Left and right are chloride ions.

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And front and back are chloride ions.

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This will also be true of every other sodium ion in the crystal.

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The reason for this, you may remember,

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Is that opposite charges attract, and this makes the crystal very stable.

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Let's now focus on the chloride ion on the center top of the diagram.

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You can see too that it is surrounded by sodium ions.

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This arrangement gives a great deal of stability to crystal structures because of this attractive force between the cations and the anions.

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The sum of the positive charges must be equal to the sum of the negative charges.

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Because these charges represent electrons that are transferred.

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And donated electrons must match the number of electrons accepted.

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Since they are the same item.

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This is a rule that you will use in writing chemical formulas.

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This formula for the ionic compounds will be the empirical formula.

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OK.

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What's an empirical formula?

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Well, glad you asked...

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An empirical formula,

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Shows the lowest whole number ratio of the atoms making up that substance.

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This periodic table only shows a few elements.

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Metals in green, nonmetals in blue.

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And these can combine to form ionic compounds.

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Our goal is to be able to name each combination.

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And predict the correct formula.

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Let's start with some useful facts.

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Metals in Group one.

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Always donate one electron when forming compounds.

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Metals in Group 2 always donate 2 electrons.

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Aluminum in Group 13 always donates 3 electrons.

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Not shown here.

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Zinc and cadmium in Group 12 always donate 2 electrons.

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And silver in Group 11 always donates 1 electron.

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It will be important to remember these.

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You will notice that nonmetals in Group 17 accept one electron.

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The nonmetals in Group 16 always accept 2.

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The nonmetals in Group 15 always accept 3 electrons.

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And those in Group 14 accept 4 electrons.

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As you see them all together, you can see that they form a.

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Nice predictable pattern.

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We will start with aluminum and oxide ions to form aluminum oxide.

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Naming ionic compounds is just a matter of naming.

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First the cation followed by the name of the anion.

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Notice that the subscripts that follow each chemical symbol indicate the number of atoms of that particular element.

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This applies to every ionic compound.

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The charges of the ions are not part of the formula.

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But they are critical to arriving to the correct subscript.

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Here is how we know that the formula must have two aluminum and three oxide ions.

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Because aluminum donates 3 electrons and oxygen accepts 2 electrons to form an oxide.

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We need to find the least common multiple of three and two.

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This is 6.

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That means that six electrons will transfer from aluminum to oxygen.

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To provide the six electrons, we will need 2 aluminum ions.

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And to receive those same 6 electrons, we will need three oxygen atoms.

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Here we have three more ionic compounds.

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Let's have a look and see how the formulas were determined.

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Aluminum donates 3 electrons.

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And sulfur accepts 2 electrons.

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The least common multiple for two and three is 6.

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So, 2 aluminum atoms and three sulfur atoms are needed to form.

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Aluminum sulfide

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Calcium donates two electrons.

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And bromine accepts one electron to become bromide.

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The least common multiple for 2 and 1 is 2.

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So, one atom of calcium and two atoms of bromide are needed to form calcium bromide.

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Sodium donates 1 electron.

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And carbonate, from the table of common ions in your reference materials, accepts 2 electrons.

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The least common multiple for one and two is 2.

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So, we will need two sodium ions and 1 carbonate ion.

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To form sodium carbonate

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We have not yet discussed what happens with the metals that are not in Group one.

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Or Group 2 or are aluminum, zinc, cadmium or silver.

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We did not focus on them yet because they are polyvalent.

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That is, they are able to form 2 or more ions.

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Iron, for example.

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Can donate 2 electrons or 3 electrons.

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To avoid confusion.

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We use a Roman numeral to indicate the number of donated electrons so that if it is iron followed by a Roman numeral 2.

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Or iron followed by a Roman numeral 3.

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We will know how many electrons they have donated.

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We don't just simply use iron.

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Our first example has aluminum which donates 3 electrons.

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And sulfite which accepts 2 electrons.

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The least common multiple is 6 electrons.

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So, we need 2 aluminum atoms.

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And three sulfite atoms.

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I'm sorry sulfite ions.

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Notice that we wrote the polyatomic ion sulfite in parentheses.

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To show that we need three of the entire sulfite.

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And this compound is called aluminum sulfite.

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Magnesium donates 2 electrons.

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And perchlorate accepts 1 electron.

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The least common multiple is 2.

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So, we will need one magnesium atom.

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And two perchlorate ions.

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To form magnesium perchlorate.

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Iron (II) donates 2 electrons.

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And permanganate accepts 1 electron.

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The least common multiple is 2.

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So, we need 1 iron (II).

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And two permanganate ions.

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To form.

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Iron (II) permanganate.

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As mentioned, this last example required a Roman numeral to indicate which.

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Ion iron was forming.

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The name of all the polyvalent metals.

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Basically the, not green ones must include a Roman numeral to indicate the charge.

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Which is the number of electrons donated.

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Group One and two metals, aluminum, zinc, cadmium and silver.

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Do not need and should never have a Roman numeral with their name.

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OK.

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Let's practice what we learned.

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First, determine the least common multiple.

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Of the ions charges.

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And then determine the number of each ion that are needed to form the formula.

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There will be 6 electrons transferred.

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Because the least common multiple for two and three is 6.

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This will require three magnesium ions.

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And two nitride ions.

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And therefore, the formula will be Mg three N two.

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To name ionic compounds, just name first the cation.

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Followed by the anion.

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Monoatomic anions end in “-ide”.

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Polyatomic anions can end in “-ide”, “-ate”, or “-ite”

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And so, we have barium chloride.

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Potassium oxide.

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Magnesium hydroxide

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And potassium nitrate.

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Also remember that metals not in groups one or two, not aluminum, Zinc, cadmium or silver.

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Are polyvalent.

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And a Roman numeral indicating the charge of the ion is part of their name.

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Here we have iron, something chloride.

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To determine the charge of the iron.

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We are going to start by calculating the charge of all the chloride ions.

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And then deduce that it is iron 2.

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This is a different compound.

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In this case, the charge of iron is +3.

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And so, we have iron three chloride.

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Remember, the Roman numeral indicates the charge of the metal.

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Because these are polyvalent metals.

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Here we have a chromium, something sulfide.

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The total charge for the three sulfide atoms is negative 6, so each of the two chromium atoms.

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Must be plus three.

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And therefore, the name is chromium (III) sulfide.

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This is the list of common ions included in your reference materials.

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Print it and have it handy because it will be very useful.

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Let's practice naming a few ironic compounds.

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For our first example.

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We realize that copper is polyvalent and will require a Roman numeral.

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We just don't know what that Roman numeral might be.

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So, by looking at the nitrate.

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Would see that a total of two electrons were accepted by both nitrates.

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We also know that there is only a single copper iron of unknown charge.

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But the total.

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Number of electrons donated by all copper.

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Must be 2.

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And so, we conclude that each copper ion must donate 2 electrons.

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Because there's only one.

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And therefore, the Roman numeral we're missing is 2.

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Our next example has a Group One metal, so no Roman numeral is needed.

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And we don't have to do any math.

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And our third example has two polyatomic ions which is kinda cool.

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We will now practice writing formulas for ionic compounds based on their names.

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Mercury (II) is so named because it donates 2 electrons.

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And nitrite accepts 1.

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So, the least common multiple for one and two is 2.

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And to have two electrons transferred requires 1 mercury ion

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And two nitrite ions.

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So, our formula is HgNO three parenthesis 2.

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Remember that parentheses must be used to add subscripts to polyatomic ions.

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Cesium is in Group one, so it donates 1 electron.

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And sulfide is in Group 16, so it accepts 2 electrons.

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Once again, the least common multiple for one and two is 2.

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So, we will need 2 carbon atoms.

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And one sulfur atom.

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And our final formula.

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Is CS2 S

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In our third example, calcium is in Group 2.

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So, it donates 2 electrons.

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And phosphate accepts 3 electrons.

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The least common multiple between two and three is 6.

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To transfer those six electrons.

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We will need three calcium atoms.

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And two phosphate ions.

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Therefore, our empirical formula will be.

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Ca3 parentheses, PO4, close parentheses, 2.

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And that's all there is.

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There isn't any more