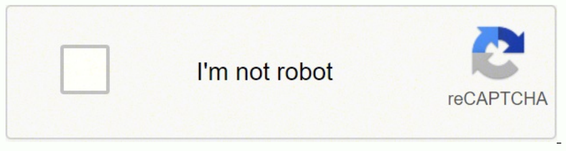

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How to balance chemical equations with charges

1 Balance the complete molecular equation. Before writing a net ionic equation, you must first make sure your starting equation is completely balanced. To balance an equation, you add coefficients in front of compounds until there is an equal number of atoms for each element on both sides of the equation. Write the number of atoms that comprise each compound on either side of the equation. Add a coefficient in front of elements that are not oxygen and hydrogen to balance each side. Balance the hydrogen atoms. Balance the oxygen atoms. Re-count the number of atoms on each side of the equation to make sure they are equal. For example, Cr + NiCl2 --> CrCl3 + Ni becomes 2Cr + 3NiCl2 --> 2CrCl3 + 3Ni. 2 Identify the states of matter of each compound in the equation. Oftentimes, you will be able to identify keywords in a problem that will tell you the state of matter for each compound. There are some rules to help you determine the state of an element or compound. If no state is provided for an element, use the state found on the periodic table. If a compound is said to be a solution, you can write it as aqueous, or (aq). If there is water in the equation, determine whether or not the ionic compound will dissolve using a solubility table. If it has high solubility, the compound will be aqueous (aq), if it has low solubility, it will be solid (s). If there is not water, the ionic compound is a solid (s). If the problem mentions an acid or a base, they will be aqueous (aq). For example, 2Cr + 3NiCl2 --> 2CrCl3 + 3Ni. Cr and Ni in their elemental forms are solids. NiCl2 and CrCl3 are soluble ionic compounds, therefore, they are aqueous. Rewritten, this equation becomes: 2Cr(s) + 3NiCl2(aq) --> 2CrCl3(aq) + 3Ni(s). 3 Determine what species will dissociate (separate into cations and anions) in solution. When a species or compound dissociates, it separates into its positive (cation) and negative (anion) components. These will be the components that get balanced at the end for the net ionic equation. Solids, liquids, gases, molecular compounds, low solubility ionic compounds, polyatomic ions, and weak acids will not dissociate. The oxides and hydroxides with alkali or alkaline earth metals will dissociate completely. High solubility ionic compounds (use solubility table) and strong acids will ionize 100% (HCl(aq), HBr(aq), HI(aq), H2SO4(aq), HClO4(aq), and HNO3(aq)).[10] Keep in mind, although polyatomic ions do not dissociate further, if they are a component of an ionic compound they will dissociate from that compound. 4 Calculate the charge of each dissociated ion. Remember that metals will be the positive cation, while non-metals will be the negative anion. Using the group number on the periodic table to determine which element will have which charge. You must also balance the charges of each ion within the compound. In our example, NiCl2 dissociates into Ni2+ and Cl- while CrCl3 dissociates into Cr3+ and Cl-. Ni has 2+ charge because Cl has a minus charge, but there are 2 atoms of it. Therefore, it must balance the 2 negative Cl ions. Cr has a 3+ charge because it must balance the 3 negative Cl ions. Remember that polyatomic ions have their own specific charge.[11] 5 Re-write the equation with the soluble ionic compounds broken down into their individual ions. Anything that will dissociate or ionize (strong acids) will simply separate into its two distinct ions. The state of matter will remain (aq), but you must ensure the equation remains balanced. Solids, liquids, gasses, weak acids, and low solubility ionic compounds will not change state or separate into ions. Simply leave them as they are. Molecular substances will simply disperse in solution, so their state will change to (aq). Three exceptions that do not become (aq) are: CH4(g), C3H8(g), and C8H18(l). Continuing our example, the total ionic equation looks like this: 2Cr(s) + 3Ni2+(aq) + 6Cl-(aq) --> 2Cr3+(aq) + 6Cl-(aq) + 3Ni(s). When Cl is not in a compound, it is not diatomic; therefore, we multiplied the coefficient by the number of atoms in the compound to get 6 Cl ions on both sides of the equation. 6 Remove the spectator ions by canceling out identical ions on each side of the equation. You can cancel only if they are 100% identical on both sides (charges, subscripts, etc.). Rewrite the action without any of the canceled species. Spectator ions do not participate in the reaction, but they are present. Finishing the example, there are 6Cl- spectator ions on each side that can be canceled out. The final net ionic equation is 2Cr(s) + 3Ni2+(aq) --> 2Cr3+(aq) + 3Ni(s). To do a check to see if your answer works, the total charge on the reactant side should equal the total charge on the product side in the net ionic equation. Advertisement 1 Memorize the prefixes for number of atoms. In naming compounds, Greek prefixes are used to indicate the number of atoms present for each element. Covalent compounds are written out as molecular formulas due to the fact that each compound is a distinct, separate molecule.[1] Covalent compounds have the first element written out completely while the second element is named with the suffix "ide." For example, diphosphorus trisulfide has a chemical formula of P2S3.[2] Below are the prefixes for 1-10: 1: Mono- 2: Di- 3: Tri- 4: Tetra- 5: Penta- 6: Hexa- 7: Hepta- 8: Octa- 9: Nona- 10: Deca- 2 Write the chemical symbol for the first element. When a compound has been written out, you must identify the elements and know their chemical symbols. The first element written is "first name" of the compound. Use the periodic table to find the chemical symbol for the element.[3] For example: Dinitrogen hexafluoride. The first element is nitrogen and the chemical symbol for nitrogen is N. Advertisement 3 Add the number of atoms as a subscript. To identify the number of atoms present for each element, you simply need to look at the prefix of the element. Memorizing the Greek prefixes will help you to be able to write chemical formulas quickly without looking anything up.[4] For example: Dinitrogen has a the prefix "di-" which means 2; therefore, there are 2 atoms of nitrogen present. Write dinitrogen as N2. 4 Write the chemical symbol for the second element. The second element is the "last name" of the compound and will follow the first element. For covalent compounds, the element name will have a suffix of "-ide" instead of the normal ending of the element.[5] For example: Dinitrogen hexafluoride. The second element is fluorine. Simply replace the "ide" ending with the actual element name. The chemical symbol for fluorine is F. 5 Add the number of atoms present as a subscript. As you did with the first element, identify the number of atoms present in the second element by reading the prefix. Using this prefix, write the number of atoms as a subscript to the right of the chemical symbol.[6] For example: Hexafluoride has a prefix of "hexa-" which means 6; therefore, there are 6 atoms of fluorine present. Write hexafluoride as F6. The final chemical formula for dinitrogen hexafluoride is N2F6. 6 Practice with some examples. When first learning chemistry, there is a lot of memorization involved. It is kind of like learning a new language. The more examples you practice with, the easier it will be to decipher chemical formulas in the future and learn the language of chemistry. Sulfur dioxide: SO2 Carbon tetrabromide: CBr4 Diphosphorus pentoxide: P2O5 Advertisement 1 Identify the chemical symbols for the cations and anions. All chemicals have what you can call a first and last name. The first name is the cation (positive ion) while the last name is the anion (negative ion). Cations are written as the element name while anions are the element name ending with the suffix "ide."[7] The chemical symbol for each element can be found on the periodic table. Unlike covalent compounds, Greek prefixes are not used to indicate the number of atoms of each element. You have to balance the charges of the elements to determine the atoms. For example: Lithium oxide is Li2O. 2 Recognize polyatomic ions. Sometimes the cation or anion is a polyatomic ion. These are molecules that have two or more atoms with ionic groups. There’s no good trick to remembering these, you just need to memorize them.[8] There are only 3 cation polyatomic ions and they are ammonium (NH4+), hydronium (H3+), and mercury(I) (Hg22+). They all have a +1 charge (though, technically, 2 mercury atoms are bonded together, which creates a 2+ charge, with each mercury cation containing a 1+ charge). The rest of the polyatomic ions have negative charges ranging from -1 to -4. Some common ones are carbonate (CO32-), sulfate (SO42-), nitrate (NO3-), and chromate (CrO42-). 3 Determine the valence charge of each element. The valence charge can be determined by looking at the position of the element on the periodic table. There are a few rules to keep in mind that help you identify the charges:[9] All group 1 elements at +1. All group 2 elements are +2. Transition elements will have Roman numerals in parentheses to indicate their charge. Silver is 1+, zinc is 2+, and aluminum is 3+. Group 17 elements are 1-. Group 16 elements are 2-. Group 15 elements are 3-. Remember, when working with polyatomic ions, use the charge of the complete polyatomic ion, rather than the individual ions. 4 Balance the positive and negative charges of the ions. Once you have identified the charge of each element (or polyatomic ion), you will use these charges to determine the number of atoms present of each element. You want the charge of the compound to equal zero so you will add atoms to balance the charges.[10] For example: Lithium Oxide. Lithium is a group 1 element and has a +1 charge. Oxygen is a group 16 element and has a 2- charge. In order to balance the 2- charge of the oxygen, you need 2 atoms of lithium; therefore, the chemical formula of lithium oxide is Li2O. 5 Practice with some examples. The best way to learn formula writing is to practice with lots of examples. Use examples in your chemistry book or look for practice sets online. Do as many as you can until you feel comfortable writing chemical formulas. Calcium Nitride: Symbol for calcium is Ca and symbol of nitrogen is N. Ca is a group 2 element and has a charge of +2. Nitrogen is a group 15 element and has a charge of 3-. To balance this, you need 3 atoms of calcium (6+) and 2 atoms of nitrogen (6-): Ca3N2. Mercury(II) Phosphate: Symbol for Mercury is Hg and phosphate is the polyatomic ion PO4. Mercury has a 2+ charge as indicated by the Roman numeral II next to it. Phosphate has a 3- charge. In order to balance them, you will need 3 atoms of mercury (6+) and 2 molecules of phosphate (6-): Hg3(PO4)2. Advertisement 1 Identify all of the cations and anions in the reactants. In a basic double replacement equation you will have 2 cations and 2 anions. The general equation takes the form of AB + CD → AD + CB, where A and C are cations and B and D are anions. You also want to determine the charges of each ion.[11] For example: AgNO3 + NaCl → ? The cations are Ag+1 and Na+1. The anions are NO31- and Cl1-. 2 Switch the ions to build the products. Once you have identified all of the ions and their charges, rearrange them so that the first cation is now paired with the second anion, and the second cation is now paired with the first anion. Remember the equation: AB + CD → AD + CB.[12] Remember to balance the charges when forming new compounds. For example: AgNO3 + NaCl → ? Ag+1 now pairs with Cl1- to form AgCl. Na+1 now pairs with NO31- to form NaNO3. 3 Write the full equation. After writing the products that will form in the equation, you can write the whole equation with both products and reactants. Keep the reactants on the left side of the equation and write the new products on the right side with a plus sign between them.[13] For example: AgNO3 + NaCl --> ? AgNO3 + NaCl --> AgCl + NaNO3 4 Balance the equation. Once you have written the equation and have all of the products and reactants you need to make sure everything is balanced. An equation is balanced only when you have the same number of atoms of every element present on both sides.[14] For example: AgNO3 + NaCl --> AgCl + NaNO3 Count the number of atoms on each side: 1 Ag left, 1 Ag right; 1 N left, 1 N right; 3 O left, 3 O right; 1 Na left, 1 Na right; 1 Cl left, 1 Cl right This equation is balanced because there are equal numbers of atoms on both the left and right side of the equation. 5 Note the states of matter. It’s important to indicate the states of matter for both the reactants and the products. There is a designated letter for each state of matter which goes in parentheses. Put this information after the formula of the substance it is describing.[15] Use "(g)" to indicate a gas, "(s)" to indicate a solid, "(l)" to indicate a liquid, and "(aq)" to indicate a substance dissolved in water. 6 Practice with some examples. The only way to get better at writing chemical equations is to actually do it. Work your way through these examples to make sure you really understand the process. NiCl2 + (NH4)2S → ? Cations: Ni2+ and NH4+ Anions: Cl1- and S2- Recombine ions to make new products: NiS + NH4Cl Write the equation: NiCl2 + (NH4)2S → NiS + NH4Cl Balance the equation: NiCl2 + (NH4)2S → NiS + 2NH4Cl Advertisement Add New Question Question In a formula, is it necessary for us to arrange them in order from the element with least atoms to the element with the most atoms? Meredith Juncker, PhD Scientific Researcher Meredith Juncker is a PhD candidate in Biochemistry and Molecular Biology at Louisiana State University Health Sciences Center. Her studies are focused on proteins and neurodegenerative diseases. Support wikiHow by unlocking this expert answer. No, it is not necessary to do this. As long as the reactants remain on the left side of the arrow and the products remain on the right side, the compounds can be written in any order, regardless of how many atoms there are in each element. Question Can balancing be done with a quicker method than the algebraic one? Meredith Juncker, PhD Scientific Researcher Meredith Juncker is a PhD candidate in Biochemistry and Molecular Biology at Louisiana State University Health Sciences Center. Her studies are focused on proteins and neurodegenerative diseases. Support wikiHow by unlocking this expert answer. Unfortunately, no. Balancing equations is often a trial and error process. A good tip to follow is to start by balancing an element that appears in only one reactant and product and then work from there. Make sure the coefficients you use to balance are in their most reduced form (if the only coefficients you have in the equation are 2 and 6, you would write them as 1 and 3.) Question Is it necessary to write down the status of the element under it? It depends upon the situation, but it's usually not necessary. The status is usually written just to make the equation more informative. If you are asked to write it for an assignment or examination, however, then you should write it down. Question What is the valency of bromine? Bromine has 7 valence electrons, therefore is an ionic compound. It is able to gain an electron to form a bromide ion with a -1 charge. It is capable of making one covalent bond. Question Can you explain why "2" is used to balance the equation in the last step of the chemical equation? So no extra atoms of any element are added, and so the number of atoms are equal on the left and right sides. Question What product is created when marsh gas and oxygen react? Marsh gas contains several chemical components. The primary one is methane. It reacts with oxygen when ignited. There are two products of this reaction, carbon dioxide and water--CH4 + 2 O2 --> CO2 + 2 H2O. Hydrogen sulfide can also be present in marsh gas in minor quantities. When ignited, its reaction with oxygen produces water and sulfur dioxide--2 H2S + 3 O2 --> 2 H2O + 2 SO2. If not ignited, it could react slowly by this equation--2 H2S + O2 --> 2 H2O + 2 S--producing water and sulfur. Question What is a balanced equation? A balanced equation is an equation in which the number of atoms in each reacting element is equal to the number of atoms in each product element. Question What is the difference between ferric and ferrous? Ferric refers to the iron oxidation state of +3 while ferrous refers to the iron oxidation state of +2. Question Why is respiration an exothermic reaction? The release of gas makes it exothermic. Respiration is not just inhalation, but exhalation, too. Question What is a saturated bond? Saturated bond is a chemical compound that has a chain of carbon atoms linked together by single bonds. See more answers Ask a Question Advertisement Thanks! Advertisement This article was co-authored by Meredith Juncker, PhD. Meredith Juncker is a PhD candidate in Biochemistry and Molecular Biology at Louisiana State University Health Sciences Center. Her studies are focused on proteins and neurodegenerative diseases. This article has been viewed 591,863 times. Co-authors: 39 Updated: April 30, 2021 Views: 591,863 Categories: Science Writing | Chemistry Print Send fan mail to authors Thanks to all authors for creating a page that has been read 591,863 times. "This is a useful addition to a large collection of information about the biochemical properties of our ancient lake (Clear Lake, CA). Knowing the proper name of a chemical that is usually abbreviated facilitates the reader's ability to find out more."..." more Share your story

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