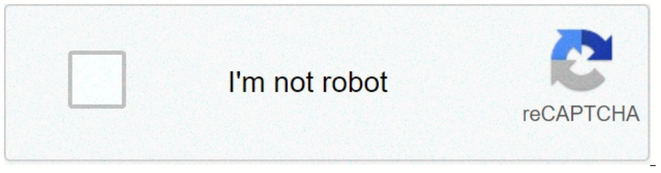

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Binary molecular compounds chemical formulas

Some families refer to the son (usually the first born) after the father. So it's somewhat common to find John Smith Jr., named after John Smith's father. Several families can take it further and name John Smith III's grandson. Countries with long royalty stories are taking naming even further. One line of kings named Henry goes to Henry the Eighth (not the sweetest guy in the world - he had six wives and two then came to untimely ends). Using name numbering adds clarity to the system - we always know which Henry we're talking about. Inorganic chemical compounds can be widely classified into two groups: ionic compounds and molecular compounds. The structure of all ionic compounds is an extended three-dimensional array of alternating positive and negative ions. Since ionic compounds do not take the form of individual molecules, they are represented by empirical formulas. Now we will begin to study the formulas and nomenclature of molecular compounds. Molecular compounds are inorganic compounds that take the form of discrete molecules. Examples include familiar substances such as water \(\left(\ce{H_2O} \right)\) and carbon dioxide \(\left(\ce{CO_2} \right)\). These compounds are very different from ionic compounds such as sodium chloride \(\left(\ce{NaCl} \right)\). Ionic compounds are formed when metal atoms lose one or more of their electrons to non-metallic atoms. The resulting notchs and eions are electrostatically attracted to each other. So what keeps the molecule atoms together? Instead of forming ions, molecule atoms share their electrons of valence in such a way that communication is formed between pairs of atoms. There are two of these bonds in the carbon dioxide molecule, each of which occurs between a carbon atom and one of two oxygen atoms. Figure \(\PageIndex{1}\): Carbon dioxide molecules consist of a central carbon atom associated with 2 oxygen atoms. Larger molecules can have many, many connections that serve to hold the molecule together. In a large sample of this molecular compound, all individual molecules are identical. Recall that the molecular formula shows the number of atoms of each element that contains the molecule. The water molecule contains two hydrogen atoms and one oxygen atom, so its formula \(\ce{H_2O}\). The octane molecule, which is a component of gasoline, contains 8 carbon atoms and 18 hydrogen atoms. Octane molecular formula: \(\ce{C_8H_{18}}\). Figure \(\PageIndex{2}\): Nitrogen dioxide \(\left(\ce{NO_2} \right)\) is a reddish-brown toxic gas that is an outstanding air pollutant produced by internal combustion engines. Binary molecular compound - a molecular compound that consists of two elements. Elements that are combined to form binary molecular compounds are both non-metatic atoms. This contrasts with the ionic compounds that formed from metallic ion and unmet ion. binary molecular compounds differ in that ion charges cannot be used to name them or write their formulas. Another difference is that the two nonmetatic atoms are often combined with each other in different ratios. Consider the elements of nitrogen and oxygen. They are combined to make multiple compounds, including \(\ce{NO}\), \(\ce{NO_2}\) and \(\ce{N_2O}\). All of them cannot be called nitric oxide. How would anyone know which one you were talking about? Each of the three compounds has very different properties and reactivity. A system to distinguish between compounds such as these is necessary. Prefixes are used in the names of binary molecular compounds to identify the number of atoms of each element. The following table shows prefixes of up to ten. Number of atom prefix tables \(\PageIndex{1}\): Numeric prefixes 1 mono-2 di-3 tri-4 tetra-5 penta-6 hexa-7 hepta-8 octa-9 nona-10 deca- Rules for using binary compound nomenclature prefix system can be summarized as follows. Generally, a less electronegatic element is written first in the formula, although there are a few exceptions. Carbon is always the first in the formula, and hydrogen after nitrogen in a formula such as \(\ce{NH_3}\). Common nonmetal order in binary formulas: \(\ce{C}\), \(\ce{P}\), \(\ce{N}\), \(\ce{H}\), \(\ce{H}\), \) (\ce{I}\), \(\ce{Br}\), \(\ce{Cl}\), \(\ce{O}\), \(\ce{F}\), \(\ce{F}\), \(\ce{F}\). When naming, the corresponding prefix is used only if there are multiple atoms in the formula. The second element is named after the first, but with the end of the item name changed to -ide. The corresponding prefix is always used for the second item. A or o at the end of the prefix usually fell out of the name when the name of the element begins with vowels. As an example, four oxygen atoms, it is tetrooxide instead of tetraoxide. Some examples of molecular compounds are listed in the table \(\PageIndex{2}\). Formula Table Name \(\PageIndex{2}\) \(\ce{NO}\) Carbon Monoxide \(\ce{N_2O}\) dinitrogen Oxide \(\ce{S_2Cl_2}\) Disulfur dichloride \(\ce{Cl_2O_7}\) dichlor heptoxide Note that that mono-prefix is not used with nitrogen in the first compound, but is used with oxygen in both of the first two examples. \(\ce{S_2Cl_2}\) emphasizes that formulas of molecular compounds do not come down to the lowest ratios. O mono- and hepty- dropped from the name paired with oxide. Summary Molecular compounds are inorganic compounds that take the form of discrete molecules. The atoms of these compounds are held together by blacksmith bonds. Prefixes are used to indicate the number of atoms of an item that are in a connection. Contributors to the CK-12 Attribution Foundation sharon Bewick, Richard Parsons, Thesis forsythe, Shonna Robinson and Jean Dupont. Defining learning goals and ionic compounds. Determine the chemical formula of a simple blacksmith connection from its name. Determine the name of a simple blacksmith-compound from its chemical formula. What elements do covalent connections? Covalent bonds are formed when two or more nonmetals are combined. For example, both hydrogen and oxygen are non-metals, and when they combine to make water, they do so by forming covalent bonds. The compounds, which consist only of non-metals or half-metals with nonmeters, will display covalent bonding and will be classified as molecular compounds. Under the general rule, compounds that involve metal binding with non-medical or semi-metaltest will reflect ionic bonding. Thus, the compound formed of sodium and chlorine will be ionic (metal and unmeter). Nitrous oxide (NO) will be a covalently linked molecule (two nonmethans), silicon dioxide (SiO2) will be a covalently linked molecule (semi-metal and non-metallic) and MgCl2 will be ionic (metal and non-medical). Polyatomic ion is an ion consisting of two or more atoms that have a charge as a group (field = a lot). Ammonium ion (see figure below) consists of one nitrogen atom and four hydrogen atoms. Together, they make up one ion with a 1+ charge and an NH4+ formula. Carbonate ion (see figure below) consists of one carbon atom and three oxygen atoms and carries a total charge of 2−. The formula for carbonate ion is CO32−. Atoms of polyatomic ion are tightly connected to each other and therefore the entire ion behaves as a whole. For several examples, see table 3.3.1. Nonmetal atoms in polyatomic ions are united by blacksmith bonds, but ion is generally involved in ion-bonding. For example, ammonium chloride (NH4Cl) has ion bonding between polyatomic ion, \(\ce{NH_4^{+}}\) and \(\ce{Cl^{−}}\) ions, but in ammonium ion (NH4+), nitrogen atoms and hydrogen are linked to covalent bonds (shown above). Ionic and covalent bonding are also found in calcium carbonate. Calcium carbonate (CaCO3) has an ionic relationship between calcium ion \(\ce{Ca^{2+}}\) and polyatomic ion\(\ce{CO_3^{2-}}\), but within carbonate ion (CO32-), carbon and oxygen atoms are connected by blacksmith bonds (shown above). Compounds that contain blacksmith bonds (also called molecular compounds) have different physical properties than ionic compounds. Because the attraction between molecules that are electrically neutral is weaker than between electrically charged ions, blacksmith compounds tend to have much lower melting and boiling temperatures than ion compounds (discussed in section 3.6). For example, water (molecular compound) boils at 100 °C, while sodium chloride (ionic compounds) boils at 1413 °C. In fact, many covalent compounds are liquids or gases at room temperature, and, in their solid states, they tend to be much softer than ionic In addition, while ionic compounds are good electricity conductors when dissolved in water, most blacksmithing compounds, being electrically neutral, are poor electricity conductors in any state. The attraction between molecules (called intermolecular forces) will be discussed in more detail in section 8.1 of exercise \(\PageIndex{1}\) Is each connection formed with ionic connections, blacksmith bonds or both? \(\ce{Ba(OH)_2}\) \(\ce{F_2}\) \(\ce{PCl_3}\) Reply a: Answer both b: covalent Answer c: covalent Chemical formulas for covalent compounds are called molecular formulas because these compounds exist as separate, discrete molecules. Typically, the molecular formula starts with non-metatalic, which is closest to the lower left corner of the periodic table, except that hydrogen is almost never written first (H2O is a notable exception). Then other non-metative characters are listed. Numeric substrings are used if there are multiple specific atoms. For example, we have already seen CH4, the molecular formula for methane. Below is the molecular formula for ammonia, NH3. Naming binary (two elemental) covalent compounds is like naming simple ionic compounds. The first element in the formula is simply specified using the item name. The second element is named, taking the stem of the name of the element and adding the suffix -ide. The numeric prefix system is used to determine the number of atoms in a molecule. The table \(\PageIndex{1}\) contains these numeric prefixes. Typically, the prefix is not added to the name of the first element if there is only one atom of the first element in the molecule. If the second element is oxygen, the final vowel will usually reach from the end of the polysylab prefix, but not monosylab (i.e. we would say monooxide rather than monooxide and trioxide rather than trsid). Table \(\PageIndex{1}\): Numeric prefixes for naming binary covlente compounds Number of atoms in compound prefix on item name 1 mono-* 2 di- 3 tri - 4 tetra- 5 penta- 6 hexa- 7 hepta- 8 octa- 9 nona-10 deca- *This prefix is not used for the name of the first element. Let's practice calling the compound, the molecular formula of which is CCl4. The name begins with the name of the first element — carbon. The second element, chlorine, becomes chloride, and we attach the correct numerical prefix (tetra-) to indicate that the molecule contains four chlorine atoms. Surrendering these pieces together gives the name tetrachloride carbon for this compound. Example \(\PageIndex{2}\) Write a molecular formula for each connection. chlorine trifles phosphorus pentachloride sulfur dioxide dinitrogen pentoxide Solution If there is no numerical prefix named of the first element, we can assume that there is only one atom of this element in the molecule. ClF3 PCl5 SO2 N2O5 (Di prefix on nitrogen that two nitrogen atoms are present.) Exercise \(\PageIndex{2}\) Write a molecular formula for each connection. nitrogen dioxide dioxigen diffluoride sulfur hexafluoride selenium Reply a: a. NO2 Answer b: O2F2 Response c: SF6 Response d: SeO Because it is so inactive, sulfur hexafleuride is used as a spark suppressor in electrical devices such as transformers. Example \(\PageIndex{3}\) Type a name for each connection. Solution bromine pentafluoride disulfur difluoride carbon monoxide Exercise \(\PageIndex{3}\) Write a name for each connection. Answer: Carbon Tetrafluoride Response b: Selenium Dychloride Response C: Sulfur Trioxide For some simple covalent compounds, we use common names rather than systematic names. We've already encountered these compounds, but we list them here explicitly: H2O: NH3 water: ammonia CH4: methane is the simplest organic compound. Organic compounds are compounds with carbon atoms and are named as a separate nomenclature, which we will implement in section 4.6 Introduction to organic chemistry. Determine whether each connection has covalent connections. Determine whether each connection has covalent connections. C2H6 C6H5Cl KC2H3O2 Ca(OH)2 Determine whether each connection has ionic connections, covalent connections, or both. Determine whether each compound has ion bonds, covalent bonds or both. FeCl3 Fe(NO3)3 (NH2)2CO SO3 What is the correct molecular formula- H4Si or SiH4? Explain. What is the right molecular formula - SF6 or F6S? Explain. Write a name for each coval compound. Write a name for each coval compound. Write a formula for each blacksmith connection. iodine trichloride disulfur dibromide is a three-oxide xenon hexafluoride Write a formula for each blacksmith compound. bor trichloride carbon dioxide tetraphosphorus dexid germanium dichloride Write two covalent compounds that have common rather than systematic names. What is the name of the simplest organic compound? What would be its name if it followed the nomenclature for binary covalent compounds? both ionic covalent ionic 4. ionic both blacksmiths siH4; except for water, hydrogen almost never rolls first into a blacksmith's compound. 6. SF6; less electronegative atom (S) is written the first silicon tetrafluoride nitrogen dioxide carbon dioxide disulfide diffosphorus pentoxide 8. carbon monoxide emissions three-oxide trifludide dezulfid germanium 10. H2O and NH3 (water and ammonia) (responses will vary) CH4; tetrahydride carbon tetrahydride

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