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Ion containing two or more atomsThis article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources:"Polyatomic ion"news newspapers books scholar JSTOR (November 2021) (Learn how and when to remove this message)An electrostatic potential map of the nitrate ion (NO3). Areas coloured translucent red, around the outside of the red oxygen atoms themselves, signify the regions of most negative electrostatic potential.A polyatomic ion (also known as a molecular ion) is a covalent bonded set of two or more atoms, or of a metal complex, that can be considered to behave as a single unit and that usually has a net charge that is not zero,[1] or in special case of zwitterion wear spatially separated charges where the net charge may be variable depending on acidity conditions. The term molecule may or may not be used to refer to a polyatomic ion, depending on the definition used. The prefix poly- carries the meaning "many" in Greek, but even ions of two atoms are commonly described as polyatomic.[2]In older literature, a polyatomic ion may instead be referred to as a radical (or less commonly, as a radical group).[citation needed] In contemporary usage, the term radical refers to various free radicals, which are species that have an unpaired electron and need not be charged.[3]A simple example of a polyatomic ion is the hydroxide ion, which consists of one oxygen atom and one hydrogen atom, jointly carrying a net charge of 1; its chemical formula is OH. In contrast, an ammonium ion consists of one nitrogen atom and four hydrogen atoms, with a charge of +1; its chemical formula is NH+4.Polyatomic ions often are useful in the context of acidbase chemistry and in the formation of salts.Often, a polyatomic ion can be considered as the conjugate acid or base of a neutral molecule. For example, the conjugate base of sulfuric acid (H2SO4) is the polyatomic hydrogen sulfate anion (HSO4). The removal of another hydrogen ion produces the sulfate anion (SO24).There are several patterns that can be used for learning the nomenclature of polyatomic anions. First, when the prefix bi is added to a name, a hydrogen is added to the ion's formula and its charge is increased by 1, the latter being a consequence of the hydrogen ion's +1 charge. An alternative to the bi- prefix is to use the word hydrogen in its place: the anion derived from H+. For example, let us consider the carbonate(CO23) ion:H+ + CO23 HCO3,which is called either bicarbonate or hydrogen carbonate. The process that forms these ions is called protonation.Most of the common polyatomic anions are oxyanions, conjugate bases of oxyacids (acids derived from the oxides of non-metallic elements). For example, the sulfate anion, SO24, is derived from H2SO4, which can be regarded as SO3 + H2O.The second rule is based on the oxidation state of the central atom in the ion, which in practice is often (but not always) directly related to the number of oxygen atoms in the ion, following the pattern shown below. The following table shows the chlorine oxyanion family:Oxidation state1+1+3+5+7Anion namechloridehypochloritechloritechlorateperchlorateFormulaClClOClO2ClO3ClO4StructureAs the number of oxygen atoms bound to chlorine increases, the chlorine's oxidation number becomes more positive. This gives rise to the following common pattern: first, the -ate ion is considered to be the base name; adding a per- prefix adds an oxygen, while changing the -ate suffix to -ite will reduce the oxygens by one, and keeping the suffix -ite and adding the prefix hypo- reduces the number of oxygens by one more, all without changing the charge. The naming pattern follows within many different oxyanion series based on a standard root for that particular series. The -ite has one less oxygen than the -ate, but different -ate anions might have different numbers of oxygen atoms.These rules do not work with all polyatomic anions, but they do apply to several of the more common ones. The following table shows how these prefixes are used for some of these common anion groups.bromidehypobromitebromitebromateperbromateBrBrOBrO2BrO3BrO4iodidehypoioditeioditeiodateperiodateIIOIO2IO3IO4 or IO56sulfidehyposulfitesulfitesulfatepersulfateS2S2O22SO23SO24SO25 or S2O28selenidehyposeleniteseleniteselenateSe2Se2O22SeO23SeO24telluridehypotelluritetelluritetellurateTe2TeO22TeO23TeO24nitridehyponitritenitritenitratepernitrateN3N2O22NO2NO3NO4phosphidehypophosphitephosphitephosphateperphosphateP3H2PO2PO33PO34PO35arsenidehypoarsenitearsenitearsenateAs3AsO32AsO33AsO34Some oxo-anions can dimerize with loss of an oxygen atom. The prefix pyro is used, as the reaction that forms these types of chemicals often involves heating to form these types of structures.[4] The prefix pyro is also denoted by the prefix di- . For example, dichromate ion is a dimer.sulfitepyrosulfiteSO23S2O25sulfatepyrosulfateSO24S2O27phosphitepyrophosphitePO33P2O45phosphatepyrophosphatePO34P2O47arsenatepyroarsenateAsO34As2O47chromatedichromateCrO24Cr2O27carbonatedicarbonateCO23C2O25selenitepyroseleniteSeO23Se2O25The following tables give additional examples of commonly encountered polyatomic ions. Only a few representatives are given, as the number of polyatomic ions encountered in practice is very large.AnionsTetrahydroxyborateB(OH)4AcetylideC22Ethoxide or ethanolateC2H5OAcetate or ethanoateCH3COO or C2H3O2BenzoateC6H5COO or C7H5O2CitrateC6H5O37FormateHCOOCarbonateCO23OxalateC2O24CyanideCNChromateCrO24DichromateCr2O27Bicarbonate or hydrogencarbonateHCO3Hydrogen phosphateHPO24Dihydrogen phosphateH2PO4Hydrogen sulfate or bisulfateHSO4ManganateMnO24PermanganateMnO4ZincateZnO22AluminateAlO2TungstateWO24Azanide or amideNH2PeroxideO22SuperoxideO2HydroxideOHBisulfideSHCyanateOCNThiocyanateSCNOrthosilicateSiO44ThiosulfateS2O23AzideN3TetraperoxochromateCr(O2)34CationsOnium ionsCarbenium ionsOthersGuanidiniumC(NH2)+3TropyliumC7H+7Mercury(I)Hg2+2AmmoniumNH+4Triphenylcarbenium(C6H5)3C+DihydrogenH+2PhosphoniumPH+4CyclopropeniumC3H+3HydroniumH3O+TrifluoromethylCF+3FluoroniumH2F+Triphenylguanidinium[5][(C6H5)NH]3C+PyryliumC5H5O+SulfoniumH3S+Many polyatomic molecules can carry spatially separated charges, forming zwitterions or, in general, polycharged polyatomic ions. A typical example are amino acids, which carry both charged amino and carboxyl groups. These charges can influence the chemical[6] and physical properties of substances.[7]Polyatomic ion structure may influence thin film growth.[8] Analyses of polyatomic ion composition is key point in mass-spectrometry.[9][10][11]Monatomic ionProtonationOnium ion^ Petrucci, Ralph H.; Herring, F. Geoffrey; Madura, Jeffry D.; Bissonnette, Carey (2017). General chemistry: principles and modern applications (Eleventhed.). Toronto: Pearson. p.A50. ISBN978-0-13-293128-1.^ "Ionic Compounds Containing Polyatomic Ions". www.chem.purdue.edu. Retrieved 2022-04-16.^ "IUPAC - radical (free radical) (R05066)". goldbook.iupac.org. Retrieved 25 January 2023.^ IUPAC, Compendium of Chemical Terminology, 2nd ed. (the "Gold Book") (1997). Online corrected version: (2006) "pyro". doi:10.1351/goldbook.P04959^ Silva, Pedro S. Pereira; Gonalves, Mauro A. Pereira; F. 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ISSN0009-2665.General Chemistry Online: Companion Notes: Compounds: Polyatomic ionsList of polyatomic ionsTables of Common Polyatomic Ions, including PDB filesRetrieved from " CO2 (carbon dioxide) is a covalent compound. It is composed of carbon and oxygen atoms covalently bonded together. Ionic compounds are formed through the transfer of electrons between a metal and a nonmetal, while covalent compounds involve the sharing of electrons between two nonmetals.Polyatomic ions are ions that are composed of two or more atoms that are linked by covalent bonds, but that still have a net deficiency or surplus of electrons, resulting in an overall charge on the group. A metal plus a polyatomic ion yields an ionic compound. Polyatomic molecules are electrically neutral groups of three or more atoms held together by covalent bonds. Molecules are distinguished from ions by their lack of electrical charge. Covalent bonding is the type of bond that holds together the atoms within a polyatomic ion. It takes two electrons to make a covalent bond, one from each bonding atom. There can be up to eight dots, for eight valence electrons. The first four electrons are placed as single electrons, then the remaining four are paired. A polyatomic ion has two or more covalently bonded atoms that act as a single ion. The polyatomic ion forms ionic bonds with other ions and acts externally as a unit, just like monatomic ions. The sulfate ion. The Lewis structure for the sulfate ion consists of a central sulfur atom with four single bonds to oxygen atoms. This yields the expected total of 32 electrons. Since the sulfur atom started with six valence electrons, two of the S-O bonds are coordinate covalent. Similarly, we can think of a polyatomic ion as a molecule that has been ionized by gaining or losing electrons. In a polyatomic ion, the group of covalently bonded atoms carries a net charge because the total number of electrons in the molecule is not equal to the total number of protons in the molecule. The carbonate ion consists of one carbon atom and three oxygen atoms, and carries an overall charge of 2. The formula of the carbonate ion is CO23. The atoms of a polyatomic ion are tightly bonded together, and so the entire ion behaves as a single unit. Polyatomic ions are ions which consist of more than one atom. For example, nitrate ion, NO3, contains one nitrogen atom and three oxygen atoms. The atoms in a polyatomic ion are usually covalently bonded to one another, and therefore stay together as a single, charged unit. The formula for nitride Ion is N-3. BRIAN M. A polyatomic ion is a group of atoms bond by covalent bonds with an unbalanced charge. A binary ionic compound is composed of atoms of two elements bond by an ionic bond. Carbon dioxide is a non-metal oxide formed by the oxidation of carbon. Carbon forms two bonds each with both oxygen atoms which are covalent bonds formed by the sharing of electron pair formed from carbon and oxygen atoms. Therefore carbon dioxide is a covalent compound and it does not contain ions. Ionic compounds are formed from strong electrostatic interactions between ions, which result in higher melting points and electrical conductivity compared to covalent compounds. Covalent compounds have bonds where electrons are shared between atoms. Acids generally contain polar covalent bonds. What are 5 examples of compounds?Sugar (sucrose C12H22O11)Table salt (sodium chloride NaCl)Water (H2O)Carbon dioxide (CO2)Sodium bicarbonate (baking soda NaHCO3) Terms in this set (6)NO nitrate.OH hydroxide.CO carbonate.PO phosphate.SO sulfate.NH ammonium. Well-known examples of such polyatomic ions are the sulfate ion (SO42), the hydroxide ion (OH), the hydronium ion (H3O+), and the ammonium ion (NH4+). Indeed, most ionic compounds contain polyatomic ions. Well-known examples are sodium hydroxide (NaOH) with OH as the polyatomic anion, calcium carbonate (CaCO3), and ammonium nitrate (NH4NO3), which contains two polyatomic ions: NH+ and NO3. A great many of them are oxyanions (polyatomic ions that contain oxygen). Polyatomic Formulas Polyatomic ions are made from more that one atom. This group of atoms act together as one unit with a single charge. The formula for the compound will contain both a cation and an anion to balance the overall charge of the compound. Polyatomic ions get their charge by transferring electrons from another element. For example In NaNO3 the Na loses an electron and the NO3 gains the electron. Since then now have opposite ionic charges (the Na becomes Na+ and the NO3 becomes NO3) the form an ionic bond. Carbonic acid is the only one shown that contains six covalent bonds, making it the correct answer. The nitrogen dioxide is a covalent compound where one nitrogen is the central atom which is bonded to two oxygen atoms, where one oxygen atom is bonded by a single bond and other oxygen atom by a double bond. By the end of this section, you will be able to:Define ionic and molecular (covalent) compoundsPredict the type of compound formed from elements based on their location within the periodic tableDetermine formulas for simple ionic compoundsIn ordinary chemical reactions, the nucleus of each atom (and thus the identity of the element) remains unchanged. Electrons, however, can be added to atoms by transfer from other atoms, lost by transfer to other atoms, or shared with other atoms. The transfer and sharing of electrons among atoms govern the chemistry of the elements. During the formation of some compounds, atoms gain or lose electrons, and form electrically charged particles called ions (Figure1).Figure1. (a) A sodium atom (Na) has equal numbers of protons and electrons (11) and is uncharged. (b) A sodium cation (Na+) has lost an electron, so it has one more proton (11) than electrons (10), giving it an overall positive charge, signified by a superscripted plus sign.You can use the periodic table to predict whether an atom will form an anion or a cation, and you can often predict the charge of the resulting ion. Atoms of many main-group metals lose enough electrons to leave them with the same number of electrons as an atom of the preceding noble gas. To illustrate, an atom of an alkali metal (group 1) loses one electron and forms a cation with a 1+ charge; an alkaline earth metal (group 2) loses two electrons and forms a cation with a 2+ charge, and so on. For example, a neutral calcium atom, with 20 protons and 20 electrons, readily loses two electrons. This results in a cation with 20 protons, 18 electrons, and a 2+ charge. It has the same number of electrons as atoms of the preceding noble gas, argon, and is symbolized Ca2+. The name of a metal ion is the same as the name of the metal atom from which it forms, so Ca2+ is called a calcium ion.When atoms of nonmetal elements form ions, they generally gain enough electrons to give them the same number of electrons as an atom of the next noble gas in the periodic table. Atoms of group 17 gain one electron and form anions with a 1 charge; atoms of group 16 gain two electrons and form ions with a 2 charge, and so on. For example, the neutral bromine atom, with 35 protons and 35 electrons, can gain one electron to provide it with 36 electrons. This results in an anion with 35 protons, 36 electrons, and a 1 charge. It has the same number of electrons as atoms of the next noble gas, krypton, and is symbolized Br. (A discussion of the theory supporting the favored status of noble gas electron numbers reflected in these predictive rules for ion formation is provided in a later chapter of this text.)Note the usefulness of the periodic table in predicting likely ion formation and charge (Figure2). Moving from the far left to the right on the periodic table, main-group elements tend to form cations with a charge equal to the group number. That is, group 1 elements form 1+ ions; group 2 elements form 2+ ions, and so on. Moving from the far right to the left on the periodic table, elements often form anions with a negative charge equal to the number of groups moved left from the noble gases. For example, group 17 elements (one group left of the noble gases) form 1 ions; group 16 elements (two groups left) form 2 ions, and so on. This trend can be used as a guide in many cases, but its predictive value decreases when moving toward the center of the periodic table. In fact, transition metals and some other metals often exhibit variable charges that are not predictable by their location in the table. For example, copper can form ions with a 1+ or 2+ charge, and iron can form ions with a 2+ or 3+ charge.Figure2. Some elements exhibit a regular pattern of ionic charge when they form ions. An ion found in some compounds used as antiperspirants contains 13 protons and 10 electrons. What is its symbol? Check Your LearningGive the symbol and name for the ion with 34 protons and 36 electrons. Magnesium and nitrogen react to form an ionic compound. Predict which forms an anion, which forms a cation, and the charges of each ion. Write the symbol for each ion and name them. Check Your LearningAluminum and carbon react to form an ionic compound. Predict which forms an anion, which forms a cation, and the charges of each ion. Write the symbol for each ion and name them. The ions that we have discussed so far are called monatomic ions, that is, they are ions formed from only one atom. We also find many polyatomic ions. These ions, which act as discrete units, are electrically charged molecules (a group of bonded atoms with an overall charge). Some of the more important polyatomic ions are listed in Table 1. Oxyanions are polyatomic ions that contain one or more oxygen atoms. At this point in your study of chemistry, you should memorize the names, formulas, and charges of the most common polyatomic ions. Because you will use them repeatedly, they will soon become familiar.Table 1. Common Polyatomic IonsChargeNameFormulaChargeNameFormula1+ammonium[latex]{\text{NH}}_{4}{}^{+}[/latex]1permanganate[latex]{\text{MnO}}_{4}{}^{-}[/latex]1acetate[latex]{\text{C}}_{2}{\text{H}}_{3}{\text{O}}_{2}{}^{-}[/latex]1hydrogen carbonate, or bicarbonate[latex]{\text{HCO}}_{3}{}^{-}[/latex]1cyanide[latex]\text{CN}^-[/latex]2carbonate[latex]{\text{CO}}_{3}{}^{2-}[/latex]1hydroxide[latex]\text{OH}^-[/latex]2peroxide[latex]{\text{O}}_{2}{}^{2-}[/latex]1nitrate[latex]{\text{NO}}_{3}{}^{-}[/latex]1hydrogen sulfate, or bisulfate[latex]{\text{HSO}}_{4}{}^{-}[/latex]1nitrite[latex]{\text{NO}}_{2}{}^{-}[/latex]2sulfate[latex]{\text{SO}}_{4}{}^{2-}[/latex]1perchlorate[latex]{\text{ClO}}_{4}{}^{-}[/latex]2sulfite[latex]{\text{SO}}_{3}{}^{2-}[/latex]1chlorate[latex]{\text{ClO}}_{3}{}^{-}[/latex]1dihydrogen phosphate[latex]{\text{H}}_{2}{\text{PO}}_{4}{}^{-}[/latex]1chlorite[latex]{\text{ClO}}_{2}{}^{-}[/latex]2hydrogen phosphate[latex]{\text{HPO}}_{4}{}^{2-}[/latex]1hypochlorite[latex]\text{ClO}^-[/latex]3phosphate[latex]{\text{PO}}_{4}{}^{3-}[/latex]Note that there is a system for naming some polyatomic ions; -ate and -ite are suffixes designating polyatomic ions containing more or fewer oxygen atoms. Per- (short for hyper) and hypo- (meaning under) are prefixes meaning more oxygen atoms than -ate and fewer oxygen atoms than -ite, respectively. For example, perchlorate is [latex]{\text{ClO}}_{4}{}^{-}[/latex], chlorate is [latex]{\text{ClO}}_{3}{}^{-}[/latex], chlorite is [latex]{\text{ClO}}_{2}{}^{-}[/latex] and hypochlorite is ClO. Unfortunately, the number of oxygen atoms corresponding to a given suffix or prefix is not consistent; for example, nitrate is [latex]{\text{NO}}_{3}{}^{-}[/latex] while sulfate is [latex]{\text{SO}}_{4}{}^{2-}.[/latex] This will be covered in more detail in the next module on nomenclature.The nature of the attractive forces that hold atoms or ions together within a compound is the basis for classifying chemical bonding. When electrons are transferred and ions form, ionic bonds result. Ionic bonds are electrostatic forces of attraction, that is, the attractive forces experienced between objects of opposite electrical charge (in this case, cations and anions). When electrons are shared and molecules form, covalent bonds result. Covalent bonds are the attractive forces between the positively charged nuclei of the bonded atoms and one or more pairs of electrons that are located between the atoms. Compounds are classified as ionic or molecular (covalent) on the basis of the bonds present in them.Ionic CompoundsWhen an element composed of atoms that readily lose electrons (a metal) reacts with an element composed of atoms that readily gain electrons (a nonmetal), a transfer of electrons usually occurs, producing ions. The compound formed by this transfer is stabilized by the electrostatic attractions (ionic bonds) between the ions of opposite charge present in the compound. For example, when each sodium atom in a sample of sodium metal (group 1) gives up one electron to form a sodium cation, Na+, and each chlorine atom in a sample of chlorine gas (group 17) accepts one electron to form a chloride anion, Cl, the resulting compound, NaCl, is composed of sodium ions and chloride ions in the ratio of one Na+ ion for each Cl ion. Similarly, each calcium atom (group 2) can give up two electrons and transfer one to each of two chlorine atoms to form CaCl2, which is composed of Ca2+ and Cl ions in the ratio of one Ca2+ ion to two Cl ions.A compound that contains ions and is held together by ionic bonds is called an ionic compound. The periodic table can help us recognize many of the compounds that are ionic: When a metal is combined with one or more nonmetals, the compound is usually ionic. This guideline works well for predicting ionic compound formation for most of the compounds typically encountered in an introductory chemistry course. However, it is not always true (for example, aluminum chloride, AlCl3, is not ionic).You can often recognize ionic compounds because of their properties. Ionic compounds are solids that typically melt at high temperatures and boil at even higher temperatures. For example, sodium chloride melts at 801 C and boils at 1413 C. (As a comparison, the molecular compound water melts at 0 C and boils at 100 C.) In solid form, an ionic compound is not electrically conductive because its ions are unable to flow (electricity is the flow of charged particles). When molten, however, it can conduct electricity because its ions are able to move freely through the liquid (Figure3).Figure3. Sodium chloride melts at 801 C and conducts electricity when molten. (credit: modification of work by Mark Blaser and Matt Evans)Watch this video to see a mixture of salts melt and conduct electricity.In every ionic compound, the total number of positive charges of the cations equals the total number of negative charges of the anions. Thus, ionic compounds are electrically neutral overall, even though they contain positive and negative ions. We can use this observation to help us write the formula of an ionic compound. The formula of an ionic compound must have a ratio of ions such that the numbers of positive and negative charges are equal. The gemstone sapphire (Figure4) is mostly a compound of aluminum and oxygen that contains aluminum cations, Al3+, and oxygen anions, O2. What is the formula of this compound?Figure4. Although pure aluminum oxide is colorless, trace amounts of iron and titanium give blue sapphire its characteristic color. (credit: modification of work by Stanislav Doronenko) Check Your LearningPredict the formula of the ionic compound formed between the sodium cation, Na+, and the sulfide anion, S2. Many ionic compounds contain polyatomic ions (Table 1) as the cation, the anion, or both. As with simple ionic compounds, these compounds must also be electrically neutral, so their formulas can be predicted by treating the polyatomic ions as discrete units. We use parentheses in a formula to indicate a group of atoms that behave as a unit. For example, the formula for calcium phosphate, one of the minerals in our bones, is Ca3(PO4)2. This formula indicates that there are three calcium ions (Ca2+) for every two phosphate [latex]\left({\text{PO}}_{4}{}^{3-}\right)[/latex] groups. The [latex]{\text{PO}}_{4}{}^{3-}[/latex] groups are discrete units, each consisting of one phosphorus atom and four oxygen atoms, and having an overall charge of 3-. The compound is electrically neutral, and its formula shows a total count of three Ca, two P, and eight O atoms. Baking powder contains calcium dihydrogen phosphate, an ionic compound composed of the ions Ca2+ and [latex]{\text{H}}_{2}{\text{PO}}_{4}{}^{-}[/latex]. What is the formula of this compound? Check Your LearningPredict the formula of the ionic compound formed between the lithium ion and the peroxide ion, [latex]{\text{O}}_{2}{}^{2-}[/latex] (Hint: Use the periodic table to predict the sign and the charge on the lithium ion.) Because an ionic compound is not made up of single, discrete molecules, it may not be properly symbolized using a molecular formula. Instead, ionic compounds must be symbolized by a formula indicating the relative numbers of its constituent cations. For compounds containing only monatomic ions (such as NaCl) and for many compounds containing polyatomic ions (such as CaSO4), these formulas are just the empirical formulas introduced earlier in this chapter. However, the formulas for some ionic compounds containing polyatomic ions are not empirical formulas. For example, the ionic compound sodium oxalate is comprised of Na+ and [latex]{\text{C}}_{2}{\text{O}}_{4}{}^{2-}[/latex] ions combined in a 2:1 ratio, and its formula is written as Na2C2O4. The subscripts in this formula are not the smallest-possible whole numbers, as each can be divided by 2 to yield the empirical formula, NaCO2. This is not the accepted formula for sodium oxalate, however, as it does not accurately represent the compounds polyatomic anion, [latex]{\text{C}}_{2}{\text{O}}_{4}{}^{2-}[/latex]. Ionic bonds form between metals and nonmetals.Molecular CompoundsMany compounds do not contain ions but instead consist solely of discrete, neutral molecules. These molecular compounds (covalent compounds) result when atoms share, rather than transfer (gain or lose), electrons. Covalent bonding is an important and extensive concept in chemistry, and it will be treated in considerable detail in a later chapter of this text. We can often identify molecular compounds on the basis of their physical properties. Under normal conditions, molecular compounds often exist as gases, low-boiling liquids, and low-melting solids, although many important exceptions exist.Whereas ionic compounds are usually formed when a metal and a nonmetal combine, covalent compounds are usually formed by a combination of nonmetals. Thus, the periodic table can help us recognize many of the compounds that are covalent. While we can use the positions of a compounds elements in the periodic table to predict whether it is ionic or covalent at this point in our study of chemistry, you should be aware that this is a very simplistic approach that does not account for a number of interesting exceptions. Shades of gray exist between ionic and molecular compounds, and youll learn more about those later. Predict whether the following compounds are ionic or covalent (molecular):KI, the compound used as a source of iodine in table saltH2O2, the bleach and disinfectant hydrogen peroxideCHCl3, the anesthetic chloroformLi2CO3, a source of lithium in antidepressants Check Your LearningUsing the periodic table, predict whether the following compounds are ionic or covalent: Metals (particularly those in groups 1 and 2) tend to lose the number of electrons that would leave them with the same number of electrons as in the preceding noble gas in the periodic table. By this means, a positively charged ion is formed. Similarly, nonmetals (especially those in groups 16 and 17, and, to a lesser extent, those in Group 15) can gain the number of electrons needed to provide atoms with the same number of electrons as in the next noble gas in the periodic table. Thus, nonmetals tend to form negative ions. Positively charged ions are called cations, and negatively charge ions are called anions. Ions can be either monatomic (containing only one atom) or polyatomic (containing more than one atom).Compounds that contain ions are called ionic compounds. Ionic compounds generally form from metals and nonmetals. Compounds that do not contain ions, but instead consist of atoms bonded tightly together in molecules (uncharged groups of atoms that behave as a single unit), are called covalent compounds. Covalent compounds usually form from two nonmetals.Using the periodic table, predict whether the following chlorides are ionic or covalent: KCl, NCl3, ICl, MgCl2, PCl5, and CCl4.Using the periodic table, predict whether the following chlorides are ionic or covalent: SiCl4, PCl3, CaCl2, CsCl, CuCl2, and CrCl3.For each of the following compounds, state whether it is ionic or covalent. If it is ionic, write the symbols for the ions involved:NF3BaO,(NH4)2CO3Sr(H2PO4)2IBrNa2OFor each of the following compounds, state whether it is ionic or covalent, and if it is ionic, write the symbols for the ions involved:KClO4 MgC2H3O2 H2SAg2SN2Cl4 Co(NO3)2For each of the following pairs of ions, write the symbol for the formula of the compound they will form:Ca2+, S2- [latex]{\text{NH}}_{4}{}^{+}[/latex], [latex]{\text{SO}}_{4}{}^{2-}[/latex]Al3+, Br (d) Na+, [latex]{\text{HPO}}_{4}{}^{2-}[/latex] (e) Mg2+, [latex]{\text{PO}}_{4}{}^{3-}[/latex]For each of the following pairs of ions, write the symbol for the formula of the compound they will form:K+, O2-[latex]{\text{NH}}_{4}{}^{+}[/latex], [latex]{\text{PO}}_{4}{}^{3-}[/latex]Al3+, O2-Na+, [latex]{\text{CO}}_{3}{}^{2-}[/latex]Ba2+, [latex]{\text{PO}}_{4}{}^{3-}[/latex]Glossarycovalent bond:attractive force between the nuclei of a molecules atoms and pairs of electrons between the atomscovalent compound:(also, molecular compound) composed of molecules formed by atoms of two or more different elementsionic bond:electrostatic forces of attraction between the oppositely charged ions of an ionic compoundionic compound:compound composed of cations and anions combined in ratios, yielding an electrically neutral substancemolecular compound:(also, covalent compound) composed of molecules formed by atoms of two or more different elementsmonatomic ion:ion composed of a single atomoxyanion:polyatomic anion composed of a central atom bonded to oxygen atomspolyatomic ion:ion composed of more than one atom CO is a covalent compound because when one nonmetal combines with another nonmetal, it usually forms a covalent compound. Here, C is a nonmetal and O is also a nonmetal. So when they combine, it forms a covalent compound. Well, now you have got to know that CO (Carbon monoxide) is a covalent compound, but let me explain the in-depth reason why CO is a covalent compound. If you are a visual learner like me, then here is a short one minute video for you. As mentioned above, you can simply remember that when the nonmetal combines with another nonmetal, the bond between them is a covalent bond. Here in CO, the C atom is a nonmetal and the O atom is also a nonmetal. Hence the bond between them is a covalent bond. In CO, there are two atoms;C and O. About Carbon (C): Carbon atom have 6 electrons. The electrons arrangement in Carbon (C) is 2, 4. So the outermost orbit of Carbon atom has 4 electrons. Now in order to achieve a stable octet, the Carbon atom needs 4 more electrons. Hence during the chemical reaction, the Carbon atom will gain 4 electrons from the combining atom to form a stable octet. About Oxygen (O): Oxygen atom have 8 electrons. The electrons arrangement in Oxygen (O) is 2, 6. So the outermost orbit of Oxygen atom has 6 electrons. Now in order to achieve a stable octet, the Oxygen atom needs 2 more electrons. Hence during the chemical reaction, the Oxygen atom will gain 2 electrons from the combining atom to form a stable octet. What happens when C and O combine? When C and O combine with each other, the Carbon atom shares 2 electrons and the Oxygen atom shares 4 electrons with each other. Because of this the carbon atom will have 8 electrons in its outermost orbit and similarly the oxygen atom will also have 8 electrons in its outermost orbit. As a result, the carbon atom as well as oxygen atom will have a stable octet. And finally, as the bond formed between the carbon and oxygen is due to the mutual sharing of electrons, it is considered a covalent bond. Thus, CO is a covalent compound. I hope you have understood the reason why CO is a covalent compound. Check out other compounds to see whether they are ionic or covalent;Is HF (Hydrogen fluoride) Ionic or Covalent?Is CS2 Ionic or Covalent?Is Na2CO3 Ionic or Covalent?Is N2 Ionic or Covalent?Is NaF Ionic or Covalent? How can financial brands set themselves apart through visual storytelling? Our experts explainhow.Learn MoreThe Motorsport Images Collections captures events from 1895 to todays most recentcoverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of EditorsPicks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? Our experts explainhow.Learn MoreThe Motorsport Images Collections captures events from 1895 to todays most recentcoverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of EditorsPicks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? 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No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. This section explores polyatomic ions, covalent compounds, and naming compounds in greater detail. The section below provides more detailed description of these topics, worked examples, practice problems and a glossary of important terms.Know the names and symbols of certain elements, as well as common molecules and ions. Write formulas for ionic and common covalent compounds.| Polyatomic Ions | Covalent Compounds || Key Concepts and Summary |Glossary | End of Section Exercises|Polyatomic IonsThe ions that we have discussed so far are called monatomic ions, that is, they are ions formed from only one atom. We also find many polyatomic ions. These ions, which act as discrete units, are electrically charged molecules (a group of bonded atoms with an overall charge). Oxyanions are polyatomic ions that contain one or more oxygen atoms. At this point in your study of chemistry, you should memorize the names, formulas, and charges of the most common polyatomic ions (Table 1). Because you will use them repeatedly, they will all (Table 1 and Table 2) soon become familiar. Polyatomic Ion NameChemical FormulaammoniumNH4+hydroniumH3O+hydroxideOHacetateCH3COOnitrateNO3permanganateMnO4hydrogen carbonateHCO3carbonateCO32-hydrogen sulfateHSO4sulfateSO42-phosphatePO43-Table 1. Common Polyatomic Ions to Be MemorizedNameFormulaoxideO2-peroxideO22-cyanideCNazideN3nitriteNO2hydrogen sulfiteHSO3sulfiteSO32-hydrogen phosphateHPO42-dihydrogen phosphateH2PO4perchlorateClO4chlorateClO3chloriteClO2hypochloriteClOchromateCrO42-dichromateCr2O72-Table 2. Common Polyatomic Ions You May EncounterNote that there is a system for naming some polyatomic ions; -ate and -ite are suffixes designating polyatomic ions containing more or fewer oxygen atoms. Per- (short for hyper) and hypo- (meaning under) are prefixes meaning more oxygen atoms than -ate and fewer oxygen atoms than -ite, respectively. For example, perchlorate is ClO4, chlorate is ClO3, chlorite is ClO2 and hypochlorite is ClO. Unfortunately, the number of oxygen atoms corresponding to a given suffix or prefix is not consistent; for example, nitrate is NO3 while sulfate is SO42.The nature of the attractive forces that hold atoms or ions together within a compound is the basis for classifying chemical bonding. When electrons are transferred and ions form, ionic bonds result. Ionic bonds are electrostatic forces of attraction, that is, the attractive forces experienced between objects of opposite electrical charge (in this case, cations and anions). When electrons are shared and molecules form, covalent bonds result. Covalent bonds are the attractive forces between the positively charged nuclei of the bonded atoms and one or more pairs of electrons that are located between the atoms. Compounds are classified as ionic or covalent (molecular) on the basis of the bonds present in them.Compounds Containing Polyatomic IonsCompounds containing polyatomic ions are named similarly to those containing only monatomic ions, except there is no need to change to an ide ending, since the suffix is already present in the name of the anion. Examples are shown in Table 3.KC2H3O2, potassium acetateNH4Cl, ammonium chlorideNaHCO3, sodium bicarbonateCaSO4, calcium sulfateAl2(CO3)3, aluminum carbonateMg3(PO4)2, magnesium phosphateTable 3. Names of Some Polyatomic Ionic Compounds Every day you encounter and use a large number of ionic compounds. Some of these compounds, where they are found, and what they are used for are listed in Table 4. Look at the label or ingredients list on the various products that you use during the next few days, and see if you run into any of those in this table, or find other ionic compounds that you could now name or write as a formula.Ionic CompoundUseNaCl, sodium chlorideordinary table saltKI, potassium iodideadded to iodized salt for thyroid healthNaF, sodium fluorideingredient in toothpasteNaHCO3, sodium bicarbonatebaking soda; used in cooking (and as antacid)Na2CO3, sodium carbonatewashing soda; used in cleaning agentsNaOCl, sodium hypochloriteactive ingredient in household bleachCaCO3 calcium carbonateingredient in antacidsMg(OH)2, magnesium hydroxideingredient in antacidsAl(OH)3, aluminum hydroxideingredient in antacidsNaOH, sodium hydroxidelye; used as drain cleanerK3PO4, potassium phosphatefood additive (many purposes)MgSO4, magnesium sulfateadded to purified waterNa2HPO4, sodium hydrogen phosphateanti-caking agent; used in powdered productsNa2SO3, sodium sulfitepreservativeTable 4. Everyday Ionic CompoundsMany ionic compounds contain polyatomic ions (Table 1 and Table 2) as the cation, the anion, or both. As with simple ionic compounds, these compounds must also be electrically neutral, so their formulas can be predicted by treating the polyatomic ions as discrete units. We use parentheses in a formula to indicate a group of atoms that behave as a unit. For example, the formula for calcium phosphate, one of the minerals in our bones, is Ca3(PO4)2. This formula indicates that there are three calcium ions (Ca2+) for every two phosphate (PO43) groups. The PO43 groups are discrete units, each consisting of one phosphorus atom and four oxygen atoms, and having an overall charge of 3. The compound is electrically neutral, and its formula shows a total count of three Ca, two P, and eight O atoms. Predicting the Formula of a Compound with a Polyatomic AnionBaking powder contains calcium dihydrogen phosphate, an ionic compound composed of the ions Ca2+ and H2PO4. What is the formula of this compound?SolutionThe positive and negative charges must balance, and this ionic compound must be electrically neutral. Thus, we must have two negative charges to balance the 2+ charge of the calcium ion. This requires a ratio of one Ca2+ ion to two H2PO4 ions. We designate this by enclosing the formula for the dihydrogen phosphate ion in parentheses and adding a subscript 2. The formula is Ca(H2PO4)2.Check Your LearningPredict the formula of the ionic compound formed between the lithium ion and the peroxide ion, O22 (Hint: Use the periodic table to predict the sign and the charge on the lithium ion.) Because an ionic compound is not made up of single, discrete molecules, it may not be properly symbolized using a molecular formula. Instead, ionic compounds must be symbolized by a formula indicating the relative numbers of its constituent ions. For compounds containing only monatomic ions (such as NaCl) and for many compounds containing polyatomic ions (such as CaSO4), these formulas are just the empirical formulas introduced earlier in this chapter. However, the formulas for some ionic compounds containing polyatomic ions are not empirical formulas. For example, the ionic compound sodium oxalate is comprised of Na+ and C2O42 ions combined in a 2:1 ratio, and its formula is written as Na2C2O4. The subscripts in this formula are not the smallest-possible whole numbers, as each can be divided by 2 to yield the empirical formula, NaCO2. This is not the accepted formula for sodium oxalate, however, as it does not accurately represent the compounds polyatomic anion, C2O42. Well revisit crystal structures of salts in Module 11.Covalent (Molecular) CompoundsThe bonding characteristics of inorganic covalent compounds are different from ionic compounds, and they are named using a different system as well. The charges of cations and anions dictate their ratios in ionic compounds, so specifying the names of the ions provides sufficient information to determine chemical formulas. However, because covalent bonding allows for significant variation in the combination ratios of the atoms in a molecule, the names for molecular compounds must explicitly identify these ratios. When two nonmetallic elements form a covalent compound, several combination ratios are often possible. For example, carbon and oxygen can form the compounds CO and CO2. Since these are different substances with different properties, they cannot both have the same name (they cannot both be called carbon oxide). To deal with this situation, we use a naming method that is somewhat similar to that used for ionic compounds, but with added prefixes to specify the numbers of atoms of each element. The name of the more metallic element (the one farther to the left and/or bottom of the periodic table) is first, followed by the name of the more nonmetallic element (the one farther to the right and/or top) with its ending changed to the suffix ide. The numbers of atoms of each element are designated by the Greek prefixes shown in Table 5.NumberPrefixNumberPrefix1 (sometimes omitted)mono-6hexa-2di-7hepta-3tri-8octa-4tetra-9nona-5penta-10deca-Table 5. Nomenclature PrefixesWhen only one atom of the first element is present, the prefix mono is usually omitted from that part. Thus, CO is named carbon monoxide, and CO2 is called carbon dioxide. When two vowels are adjacent, the a in the Greek prefix is usually dropped. Some other examples are shown in Table 6.CompoundNameCompoundNameSO2sulfur dioxideBCl3boron trichlorideSO3sulfur trioxideSF6sulfur hexafluorideNO2nitrogen dioxidePF5phosphorus pentafluorideN2O4dinitrogen tetroxideP4O10tetraphosphorus decaoxideN2O5dinitrogen pentoxideIF7iodine heptafluorideTable 6. Names of Some Molecular Compounds Composed of Two ElementsThere are a few common names that you will encounter as you continue your study of chemistry. For example, although NO is often called nitric oxide, its proper name is nitrogen monoxide. Similarly, N2O is known as nitrous oxide even though our rules would specify the name dinitrogen monoxide. (And H2O is usually called water, not dihydrogen monoxide.) You should commit to memory the common names of compounds as you encounter them. Naming Covalent CompoundsName the following covalent compounds:(a) SF6(b) N2O3(c) Cl2O7(d) P4O6SolutionBecause these compounds consist solely of nonmetals, we use prefixes to designate the number of atoms of each element:(a) sulfur hexafluoride(b) dinitrogen trioxide(c) dichlorine heptoxide(d) tetraphosphorus hexoxideCheck Your LearningWrite the formulas for the following compounds:(a) phosphorus pentachloride(b) dinitrogen monoxide(c) iodine heptafluoride(d) carbon tetrachloride (a) PCl5; (b) N2O; (c) IF7; (d) CCl4The following website provides practice with naming chemical compounds and writing chemical formulas. You can choose binary, polyatomic, and variable charge ionic compounds, as well as molecular compounds.Key Concepts and SummaryChemists use nomenclature rules to clearly name compounds. Ionic and molecular compounds are named using somewhat different methods. Some compounds contain polyatomic ions; the names of common polyatomic ions should be memorized. Molecular compounds can form with different ratios of their elements, so prefixes are used to specify the numbers of atoms of each element in a molecule of the compound. Examples include SF6, sulfur hexafluoride, and N2O4, dinitrogen tetroxide.Glossarypolyatomic ionion composed of more than one atommonoatomic ionion composed of one atomoxyanionpolyatomic ion that contains one or more oxygen atomsionic bondelectrons are transferred to form an ionic compound held by electrostatic forcescovalent bondelectrons are shared to form a covalent compound held by attractive forcesFor each of the following pairs of ions, write the symbol for the formula of the compound they will form:NH4+, SO42Na+, HPO42Mg2+, PO43NH4+, PO43Na+, CO32Ba2+, PO43Write the formulas of the following compounds:chlorine dioxidedinitrogen tetraoxidepotassium phosphidesilver(I) sulfidealuminum nitridesilicon dioxideWrite the formulas of the following compounds:lithium carbonatesodium perchloratebarium hydroxideammonium carbonatesulfuric acidcalcium acetatemagnesium phosphatesodium sulfite(a) (NH4)2SO4; (b) Na2HPO4; (c) Mg3(PO4)2; (d) (NH4)3PO4; (e) Na2CO3; (f) Ba3(PO4)2(a) ClO2; (b) N2O4; (c) K3P; (d) Ag2S; (e) AlN; (f) SiO2(a) Li2CO3; (b) NaClO4; (c) Ba(OH)2; (d) (NH4)2CO3; (e) H2SO4; (f) Ca(C2H3O2)2; (g) Mg3(PO4)2; (h) Na2SO3No, CO2 is not a polyatomic ion. It is a neutral molecule because it has no charge. A polyatomic ion is a charged species (ion) composed of two or more atoms covalently bonded.Analogy / ExampleRelated questions:How to do the dot and cross diagram of the carbonate ion?In the Lewis diagram for SCN-, are the formal charges as follows: S(1), C(+1), N(1), S(0), C(1), N(0), S(+1), C(0), N(1), S(1), C(0), N(+1), S(1), C(0), N(0)? True/FalseHow can you find the charge of polyatomic ions?

Covalentie. Co ionic or covalent. Are polyatomics ionic or covalent. Ionic or covalent.