9.1 Naming Ions

Connecting to Your World

In the play *Romeo and Juliet*, William Shakespeare wrote, "What's in a name? That which we call a rose/By any other name would smell as sweet." A rose is *rosa* in Spanish, *warda* in Arabic, and *julab* in Hindi. To truly understand another culture, you must first learn the language used in that culture. Similarly, to understand chemistry, you must learn its language. Part of learning the language of chemistry involves understanding how to name ionic compounds. For this you need to know how to name ions.

Guide for Reading

Key Concepts

- How are the charges of Group A metal and nonmetal ions related to their positions in the periodic table?
- How are the charges of some transition metal ions determined?
- What are the two endings of the names of most polyatomic ions?

Vocabulary

monatomic ion

polyatomic ion

Reading Strategy

Outlining As you read, make an outline of the most important ideas in this section. Use the red headings as the main topics and the blue headings as subtopics. Add a sentence or a note after each heading to provide key information about the topic.

Monatomic Ions

Ionic compounds consist of a positive metal ion and a negative nonmetal ion combined in a proportion such that their charges add up to a net charge of zero. For example, the ionic compound sodium chloride (NaCl) consists of one sodium ion (Na^+) and one chloride ion (Cl^-). Probably you are already familiar with the name and formula of sodium chloride, which is common table salt. But it is important, in learning the language of chemistry, to be able to name and write the chemical formulas for all ionic compounds. The first step is to learn about the ions that form ionic compounds. Some ions, called **monatomic ions,** consist of a single atom with a positive or negative charge resulting from the loss or gain of one or more valence electrons, respectively.

Cations Recall that metallic elements tend to lose valence electrons. Lithium, sodium, and potassium in Group 1A lose one electron to form cations. All the Group 1A ions have a 1+ charge (Li^+, Na^+, K^+, Rb^+, and Cs^+). Magnesium and calcium are Group 2A metals. They tend to lose two electrons to form cations with a 2+ charge (Mg^{2+} and Ca^{2+}), as do all the other Group 2A metals. Aluminum is the only common Group 3A metal. As you might expect, it tends to lose three electrons to form a 3+ cation (Al^{3+}). **When the metals in Groups 1A, 2A, and 3A lose electrons, they form cations with positive charges equal to their group number.** Figure 9.1 shows some of the elements whose ionic charges can be obtained from their positions in the periodic table. The names of the cations of the Group 1A, Group 2A, and Group 3A metals are the same as the name of the metal, followed by the word *ion* or *cation.* Thus Na^+ is the sodium ion (or cation), Ca^{2+} is the calcium ion (or cation), and Al^{3+} is the aluminum ion (or cation).

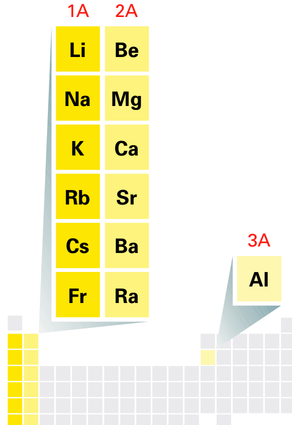

Figure 9.1 The representative elements shown form positive ions with charges equal to their group numbers. **Applying Concepts** ***Are the ions anions or cations?***

Section Resources

Print

- **Guided Reading and Study Workbook,** Section 9.1
- **Core Teaching Resources,** Section 9.1 Review, Interpreting Graphics
- **Transparencies,** T94–T95

Technology

- **Interactive Textbook with ChemASAP,** Problem-Solving 9.1, Assessment 9.1
- **Go Online,** Section 9.1

9.1

1 FOCUS

Objectives

9.1.1 **Identify** the charges on monatomic ions by using the periodic table, and **name** the ions.

9.1.2 **Define** a polyatomic ion and write the names and formulas of the most common polyatomic ions.

9.1.3 **Identify** the two common endings for the names of most polyatomic ions.

Guide for Reading

Build Vocabulary L2

Word Parts Ask, **Can you think of words that begin with the prefixes *mono–* and *poly–*?** *(Students may respond with words such as monotone, monochrome, polygon, or polygamy.)* Discuss the meanings of these words and then ask, **How do you think monatomic ions and polyatomic ions might differ?** *(A monatomic ion has one atom; a polyatomic ion has more than one atom.)*

Reading Strategy L2

Compare and Contrast As students read the section, have them make a chart that compares monatomic ions and polyatomic ions as to charge, composition, and name endings.

2 INSTRUCT

Connecting to Your World

Comment that you couldn't talk with people in a different country unless you knew their language. Emphasize that chemists everywhere use the same chemical language. Ask, **Why is it important that there be only one language of chemistry?** *(Chemists need to communicate with one another and having the same names for compounds makes this easier.)*

Answers to...

Figure 9.1 cations

Section 9.1 (continued)

Monatomic Ions

Use Visuals **L1**

Figures 9.1 and 9.2 Have students note that in each figure, the periodic table is shown in the background to help them locate the groups being discussed. Ask, **How do the ions formed by metals in Groups 1A, 2A, and 3A differ from the ions formed by nonmetals in Groups 5A, 6A, and 7A?** *(Groups 1A, 2A, and 3A form positive ions; Groups 5A, 6A, and 7A form negative ions.)* Ask, **Are the ions formed by the transition metals cations or anions?** *(They are cations.)*

CLASS Activity

Determining Ionic Charge **L2**

Purpose Students gain practice in using the periodic table to determine the charge on ions.

Materials A display-size periodic table

Procedure Have one student point, one-by-one and in no particular order, to any of the elements shown prominently in Figures 9.1 and 9.2. Have the other students vie to identify the charge of the ion formed by each element.

TEACHER Demo

Colorful Ions **L2**

Purpose Students see the various colors of solutions of transition metal ions and practice naming them.

Materials Beakers containing solutions of soluble metal salts, for example: $MnCl_2$, $FeCl_2$, $CoCl_2$, $NiCl_2$, and $CuCl_2$, or use the ions in Figure 9.3.

Procedure Write the symbols for the metal ions on the board. Have students describe the colors of the solutions. Ask them to use Table 9.2 to write the Stock and classical names of each cation. Ask students to suggest why chemists currently use only the Stock system for naming ions.

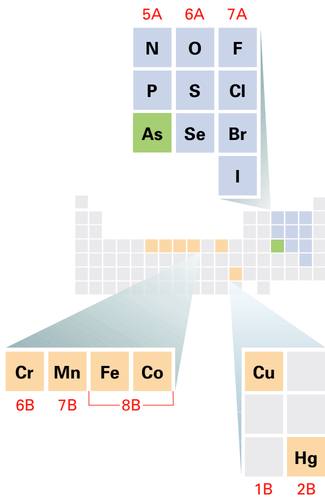

Figure 9.2 Note the positions of the nonmetals and the metalloid, arsenic. These elements form anions. Common transition elements that form more than one ion are also shown. **Applying Concepts** ***Do the transition metals form anions or cations?***

Table 9.1

Ionic Charges of Representative Elements

1A	2A	3A	4A	5A	6A	7A	8A
Li^{+}	Be^{2+}			N^{3-}	O^{2-}	F^{-}	
Na^{+}	Mg^{2+}	Al^{3+}		P^{3-}	S^{2-}	Cl^{-}	
K^{+}	Ca^{2+}			As^{3-}	Se^{2-}	Br^{-}	
Rb^{+}	Sr^{2+}					I^{-}	
Cs^{+}	Ba^{2+}						

Anions Nonmetals tend to gain electrons to form anions, so the charge of a nonmetallic ion is negative. **The charge of any ion of a Group A nonmetal is determined by subtracting 8 from the group number.** The elements in Group 7A form anions with a 1− charge (7 − 8 = −1). The name of an anion is not the same as the element's name. Anion names start with the stem of the element name and end in *-ide*. For example, two elements in Group 7A are fluorine and chlorine. The anions for these nonmetals are the fluor*ide* ion (F^{-}) and chlor*ide* ion (Cl^{-}). Anions of nonmetals in Group 6A have a 2− charge (6 − 8 = −2). Group 6A elements, oxygen and sulfur, form the ox*ide* anion (O^{2-}) and the sulf*ide* anion (S^{2-}), respectively. The three nonmetals in Group 5A—nitrogen, phosphorus, and arsenic—can form anions with a 3− charge (5 − 8 = −3). These have the symbols N^{3-}, P^{3-}, and As^{3-} and are called, respectively, nitride ion, phosphide ion, and arsenide ion. Figure 9.2 shows the Group A elements that form anions. Table 9.1 summarizes the ionic charges of representative elements that can be obtained from the periodic table.

The majority of the elements in the two remaining representative groups, 4A and 8A, usually do not form ions.

Checkpoint ***What is the name of the anion N^{3-}?***

Ions of Transition Metals The metals of Groups 1A, 2A, and 3A consistently form cations with charges of 1+, 2+, and 3+, respectively. Many of the transition metals (Groups 1B–8B) form more than one cation with different ionic charges. Some of these are shown in Figure 9.2. **The charges of the cations of many transition metal ions must be determined from the number of electrons lost.** For example, the transition metal iron forms two common cations, Fe^{2+} (two electrons lost) and Fe^{3+} (three electrons lost). Cations of tin and lead, the two metals in Group 4A, can also have more than one charge. Table 9.2 lists symbols for common ions of many of the metals that form more than one ion. Two methods are used to name these ions. The preferred method is called the Stock system. In the Stock system, a Roman numeral in parentheses is placed after the name of the element to indicate the numerical value of the charge. Table 9.2 shows that the cation Fe^{2+} is named iron(II) ion. Note that no space is left between the element name and the Roman numeral in parentheses. The name for Fe^{2+} is read "iron two ion." The Fe^{3+} ion is named iron(III) ion and is read "iron three ion." Colorful solutions of the transition metal ions Co^{3+}, Cr^{3+}, Fe^{3+}, Ni^{2+}, and Mn^{2+} are shown in Figure 9.3.

Figure 9.3 The ions of these transition metals produce an array of colors when dissolved in water. From left to right, the ions are Co^{3+}, Cr^{3+}, Fe^{3+}, Ni^{2+}, and Mn^{2+}.

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An older, less useful method for naming these cations uses a root word with different suffixes at the end of the word. The older, or classical, name of the element is used to form the root name for the element. For example, *ferrum* is Latin for iron, so *ferr-* is the root name for iron. The suffix *-ous* is used to name the cation with the lower of the two ionic charges. The suffix *-ic* is used with the higher of the two ionic charges. Using this system, Fe^{2+} is the ferrous ion, and Fe^{3+} is the ferric ion, as shown in Table 9.2. Notice that you can usually identify an element from what may be an unfamiliar classical name by looking for the element's symbol in the name. Thus *fer*rous (Fe) is iron; *cu*prous (Cu) is copper; and *stan*nous (Sn) is tin. A major disadvantage of using classical names for ions is that they do not tell you the actual charge of the ion. A classical name tells you only that the cation has either the smaller (*-ous*) or the larger (*-ic*) charge of the pair of possible ions for that element.

A few transition metals have only one ionic charge. The names of these cations do not have a Roman numeral. These exceptions include silver, with cations that have a 1+ charge (Ag^+), as well as cadmium and zinc, with cations that have a 2+ charge (Cd^{2+} and Zn^{2+}). As Figure 9.4 shows, many transition metal compounds are colored and can be used as pigments. Pigments are compounds having intense colors that can be used to color other materials. For example, compounds of chromium are pigments used to make yellow, orange, red, or green paints. Various cadmium compounds range in color from yellow to red and maroon. Prussian blue is an important pigment composed of the transition element iron combined with carbon, hydrogen, and nitrogen.

Figure 9.4 Many transition metals form brightly colored compounds that are used in making artists' paints.

Table 9.2

Symbols and Names of Common Metal Ions with More than One Ionic Charge

Symbol	Stock name	Classical name
Cu^+	Copper(I) ion	Cuprous ion
Cu^{2+}	Copper(II) ion	Cupric ion
Fe^{2+}	Iron(II) ion	Ferrous ion
Fe^{3+}	Iron(III) ion	Ferric ion
*Hg_2^{2+}	Mercury(I) ion	Mercurous ion
Hg^{2+}	Mercury(II) ion	Mercuric ion
Pb^{2+}	Lead(II) ion	Plumbous ion
Pb^{4+}	Lead(IV) ion	Plumbic ion
Sn^{2+}	Tin(II) ion	Stannous ion
Sn^{4+}	Tin(IV) ion	Stannic ion
Cr^{2+}	Chromium(II) ion	Chromous ion
Cr^{3+}	Chromium(III) ion	Chromic ion
Mn^{2+}	Manganese(II) ion	Manganous ion
Mn^{3+}	Manganese(III) ion	Manganic ion
Co^{2+}	Cobalt(II) ion	Cobaltous ion
Co^{3+}	Cobalt(III) ion	Cobaltic ion

*A diatomic elemental ion.

CLASS Activity

Symbols for Monatomic Ions L2

Purpose Students use the periodic table for writing symbols for monatomic ions.

Materials Blank photocopy of the periodic table for each pair of students.

Procedure Have students work in pairs. Allow them to refer to their textbooks or other resource materials. In the element blocks on the blank periodic table, have them write the symbols and names of the cations and anions of as many elements as possible. Have them use their tables to identify any trends in ionic charges. Encourage them to keep their tables for reference.

Relate L2

Divide students into research teams to gather data about paint pigments from different sources. Possible assignments: (1) Examine the pigments available at an art-supply store and try to tell from the names what they contain. (2) Interview an art teacher about the pigments that he or she prefers. (3) Use the library or Internet to research which pigments were available and popular during earlier eras; look for information about natural sources of pigments. (4) Invite a curator or art restorer from a local museum to talk about using pigments to repair damaged art, authenticate art, or unmask a forgery.

Differentiated Instruction

Special Needs L1

For some students, the charge that results when electrons are transferred is counterintuitive — additions result in a negative charge, subtractions result in a positive charge. Give students different-colored disks to represent protons and electrons in neutral atoms. Remove or add electrons and ask students to find the charge of the resulting "ion."

Answers to...

Figure 9.2 cations

Checkpoint nitride ion

Careers in Chemistry

Pharmacist

Although pharmacists must often work in the evenings and on weekends, they are well paid and employment opportunities for pharmacists during the coming decade are expected to grow faster than for many other professions. The American Association of Colleges of Pharmacy (ASCP) operates the Pharmacy College Application Service to allow students to use a single web-based application for all applications to schools of pharmacy.

Go Online PHSchool.com

Have students research chemistry-related careers in the library or on the Internet. Students can then construct a table that describes the nature of the work, educational and training requirements, employment outlook, working conditions, and other necessary information.

CONCEPTUAL PROBLEM 9.1

Answers

1. **a.** selenide ion, anion
   b. barium ion, cation
   c. phosphide ion, anion
2. **a.** three electrons lost
   b. two electrons gained
   c. one electron lost

Practice Problems Plus L2

Write the symbol (including charge) for the ion formed by each element and classify each as an anion or a cation.

a. arsenic (*As^{3-}, anion*)
b. beryllium (*Be^{2+}, cation*)
c. astatine (*At^{-}, anion*)
d. gallium (*Ga^{3+}, cation*)

Careers in Chemistry

Pharmacist

Doctors provide written instructions to pharmacists about medicines they wish to have dispensed to their patients. It is the responsibility of the pharmacist to prepare the medicine and to advise the patient about possible side effects. Pharmacists also make sure that physicians have not prescribed a medicine or dosage that could harm the patient.

A person with some knowledge of chemistry and biology could become a pharmacist's assistant with on-the-job training. Advancement to the position of pharmacist requires a college degree in pharmacy. This degree includes the study of chemistry, biology, mathematics, and statistics. Pharmacists must also learn about the biological effects of drugs and drug interactions (pharmacology). To obtain a license to dispense drugs, pharmacists are required to pass a state test and must work for a specified period of time under the supervision of another pharmacist.

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CONCEPTUAL PROBLEM 9.1

Classifying and Naming Cations and Anions

Write the symbol for the ion formed by each element. Classify the ions as cations or anions and name the ion. Potassium and iodine combine to form potassium iodide, an additive to table salt that protects the thyroid gland.

a. potassium **b.** iodine **c.** sulfur **d.** lead, 4 electrons lost

1 Analyze ***Identify the relevant concepts.***

a.–d. Use the periodic table or the electrons lost to write the symbol for the ion. Ions with positive charges are cations; ions with negative charges are anions. Apply the rules for naming cations and anions. The names of nonmetallic anions end in *-ide.* Metallic cations take the name of the metal. If the metal ion can have more than one ionic charge, use a Roman numeral in the Stock name or use the classical name with a suffix.

2 Solve ***Apply concepts to this situation.***

a. K^{+}: cation, potassium ion
b. I^{-}: anion, iodide ion
c. S^{2-}: anion, sulfide ion
d. Pb^{4+}: cation, lead(IV) or plumbic ion

The ions formed by metals are cations and the ions formed by nonmetals are anions. The rules for naming have been correctly applied.

Practice Problems

1. Name the ions formed by these elements and classify them as anions or cations.
   a. selenium **b.** barium **c.** phosphorus
2. How many electrons were lost or gained to form these ions?
   a. Fe^{3+} **b.** O^{2-} **c.** Cu^{+}

Interactive Textbook
Problem-Solving 9.1 Solve Problem 1 with the help of an interactive guided tutorial.
with ChemASAP

Facts and Figures

Potassium Iodide as Radiation Medicine

Potassium is stockpiled for use in the event of a nuclear accident that results in fallout of radioactive iodine-131. Whether radioactive or not, absorbed iodine accumulates in the thyroid gland. If a dose of nonradioactive KI is ingested in a timely way after a nuclear accident, iodine-131 is less likely to enter the thyroid gland. Iodine-131 has a relatively short half-life of eight days, but can cause thyroid cancer, especially in children.

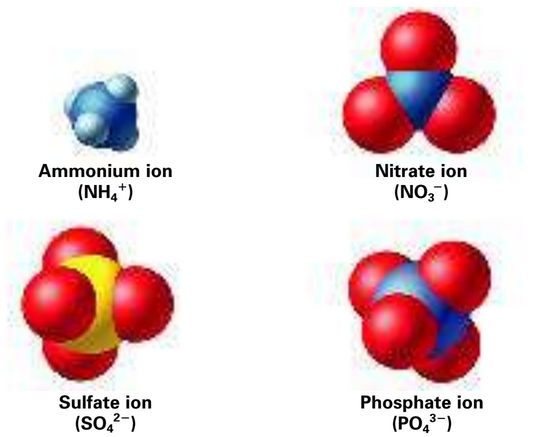


Figure 9.5 These molecular models show the arrangement of atoms in four common polyatomic ions. **Interpreting Diagrams** ***How does the ammonium ion differ from the other three?***

Polyatomic Ions

Some ions, called **polyatomic ions,** are composed of more than one atom. The sulfate anion consists of one sulfur atom and four oxygen atoms. These five atoms together comprise a single anion with an overall 2− charge. The formula is written SO_4^{2-}. Polyatomic ions, such as the sulfate ion, are tightly bound groups of atoms that behave as a unit and carry a charge. You can see the structures of four common polyatomic ions in Figure 9.5.

The names and formulas of some common polyatomic ions are shown in Table 9.3 grouped according to their charges. **The names of most polyatomic anions end in *-ite* or *-ate.*** For example, notice the endings of the names of the hypochlor*ite* ion (ClO^-) and the hydrogen carbon*ate* ion (HCO_3^-). Also notice that three important ions have different endings. The positively charged ammonium cation (NH_4^+) ends in *-ium*, and the cyanide ion (CN^-) and the hydroxide ion (OH^-) end in *-ide*. Use Table 9.3 as a reference until you have memorized its contents.

Sometimes the same two or three elements combine in different ratios to form different polyatomic ions. You can see examples in Table 9.3. Look for pairs of ions for which there is both an *-ite* and an *-ate* ending, for example, sulfite and sulfate. In the list below, examine the charge on each ion in the pair. Note the number of oxygen atoms and the endings on each name. You should be able to discern a pattern in the naming convention.

-ite	*-ate*
SO_3^{2-}, sulfite	SO_4^{2-}, sulfate
NO_2^-, nitrite	NO_3^-, nitrate
ClO_2^-, chlorite	ClO_3^-, chlorate

The charge on each polyatomic ion in a given pair is the same. The *-ite* ending indicates one less oxygen atom than the *-ate* ending. However, the ending does not tell you the actual number of oxygen atoms in the ion. For example, the nitrite ion has two oxygen atoms and the sulfite ion has three oxygen atoms. All anions with names ending in *-ite* or *-ate* contain oxygen.

Checkpoint ***What is the formula for the hydrogen sulfite polyatomic ion?***

Table 9.3

Common Polyatomic Ions

Formula	Name
Charge = 1−	
$H_2PO_4^-$	Dihydrogen phosphate
$C_2H_3O_2^-$	Acetate
HSO_3^-	Hydrogen sulfite
HSO_4^-	Hydrogen sulfate
HCO_3^-	Hydrogen carbonate
NO_2^-	Nitrite
NO_3^-	Nitrate
CN^-	Cyanide
OH^-	Hydroxide
MnO_4^-	Permanganate
ClO^-	Hypochlorite
ClO_2^-	Chlorite
ClO_3^-	Chlorate
ClO_4^-	Perchlorate
Charge = 2−	
HPO_4^{2-}	Hydrogen phosphate
$C_2O_4^{2-}$	Oxalate
SO_3^{2-}	Sulfite
SO_4^{2-}	Sulfate
CO_3^{2-}	Carbonate
CrO_4^{2-}	Chromate
$Cr_2O_7^{2-}$	Dichromate
SiO_3^{2-}	Silicate
Charge = 3−	
PO_3^{3-}	Phosphite
PO_4^{3-}	Phosphate
Charge = 1+	
NH_4^+	Ammonium

Polyatomic Ions

Discuss L2

Write the following formulas on the board: NaOH, H_2SO_4, NH_4NO_3, Na_2CO_3. Ask students what these compounds have in common. (*Students may note that they all contain oxygen.*) Tell students that this is an important observation, then explain that all of these compounds contain ions that are made up of more than one type of atom. In ions such as these, oxygen is almost always present.

Use Visuals L1

Table 9.3 Call attention to how the table is divided into sections according to charge. More than half of the ions have a charge of 1–. Only two ions have charges of 3–, and both of these contain the phosphorus atom. The ammonium ion is the only common polyatomic ion with a 1+ charge, and it does not contain oxygen. The remaining ions have charges of 2–. Have students pick out the *–ate* / *-ite* pairs and write their formulas on the board. Have students note that the members of each pair have the same charge. It is not the charge but the number of oxygen atoms in the members of an *-ate/-ite* pair that determines the endings of the names.

Discuss L2

Write on the board the names and formulas of at least ten different polyatomic ions. Purposely mismatch the names so that they do not appear with the correct formulas. Challenge students to see how quickly they can rearrange the names and formulas so that they are paired correctly.

Differentiated Instruction

English Learners L2

Have students prepare flash cards with the name of a polyatomic ion on one side and its formula on the other side. Pairs of students can use the flash cards to quiz each other on the names and formulas of these ions. Set aside a few minutes at the beginning or end of several class periods for this activity.

Facts and Figures

Two Kinds of Bonding

When an ionic compound forms between a metal ion and a polyatomic ion, the resulting compound contains both ionic bonds and covalent bonds. The atoms in all polyatomic ions are held together by covalent bonds.

Answers to...

Figure 9.5 The ammonium ion is a cation and does not contain oxygen.

Checkpoint HSO_3^-

CLASS Activity

Shapes of Polyatomic Ions L2

Purpose Students visualize the geometry of some polyatomic ions.

Materials foam balls and wooden sticks

Procedure Pairs of students can research the three-dimensional structure of one of the polyatomic ions in Table 9.3. Have them prepare a ball-and-stick model of the ion. They may wish to differentiate atoms by size or color. Make sure that they pay attention to correct geometric placement of atoms.

3 ASSESS

Evaluate Understanding L2

Write these symbols on the chalkboard: K, NH_3, CN, Mg, O, OH, Co, NH_4, Pb, PO_4, Ar, ClO, H_2O, and Zn. Ask students to identify which species can exist as ions by simply attaching a charge. *(K, CN, Mg, O, OH, Co, NH_4, Pb, PO_4, ClO, and Zn)* For these ions, ask students to identify the charges and name the ion.

Reteach L1

Remind students that one of the most important properties of a compound is that it is electrically neutral. Because polyatomic ions carry a charge, they are always combined with other ions in compounds.

Writing Activity

Sodium is found in higher concentrations in extra-cellular fluids, such as plasma. Potassium is found in higher concentrations within cells. Both ions are involved in transmission of nerve impulses.

Interactive Textbook

If your class subscribes to the Interactive Textbook, use it to review key concepts in Section 9.1.

with ChemASAP

Figure 9.6 Hydrogen-containing polyatomic ions are part of many compounds that affect your daily life. **a** Sodium hydrogen carbonate, which contains the HCO_3^- ion, can relieve an upset stomach. **b** The presence of dissolved HCO_3^-, HPO_4^{2-}, and $H_2PO_4^-$ ions in your blood is critical for your health. **c** Crop dusters spread fertilizers containing HPO_4^{2-} and $H_2PO_4^-$ ions.

When the formula for a polyatomic ion begins with H (hydrogen), you can think of the H as representing a hydrogen ion (H^+) combined with another polyatomic ion. For example, HCO_3^- is a combination of H^+ and CO_3^{2-}. Note that the charge on the new ion is the algebraic sum of the ionic charges.

$$\underset{\text{carbonate}}{H^+ + CO_3^{2-}} \longrightarrow \underset{\text{hydrogen carbonate}}{HCO_3^-}$$

$$\underset{\text{phosphate}}{H^+ + PO_4^{3-}} \longrightarrow \underset{\text{hydrogen phosphate}}{HPO_4^{2-}}$$

$$\underset{\text{hydrogen phosphate}}{H^+ + HPO_4^{2-}} \longrightarrow \underset{\text{dihydrogen phosphate}}{H_2PO_4^-}$$

The hydrogen carbonate anion (HCO_3^-), the hydrogen phosphate anion (HPO_4^{2-}), and the dihydrogen phosphate anion ($H_2PO_4^-$) are essential components of living systems. In contrast, the cyanide ion (CN^-) is extremely poisonous to living systems because it blocks a cell's means of producing energy. Figure 9.6 shows some uses for compounds with hydrogen-containing polyatomic ions.

9.1 Section Assessment

3. **Key Concept** Explain how the charges of Group A metal and nonmetal ions are related to their positions in the periodic table.
4. **Key Concept** How are the charges of some transition metal ions determined?
5. **Key Concept** What are the usual endings for the names of polyatomic ions?
6. What are the charges on ions of Group 1A, Group 3A (aluminum), and Group 5A?
7. How does a polyatomic anion differ from a monatomic anion?
8. Write the symbol for the ion of each element. Classify the ion as an anion or a cation, and name the ion.
   a. potassium **b.** oxygen
   c. tin (2 electrons lost) **d.** bromine
   e. beryllium **f.** cobalt (3 electrons lost)
9. Write the symbol or formula (including charge) for each of the following ions.
   a. ammonium ion **b.** tin(II) ion
   c. chromate ion **d.** nitrate ion

Writing Activity

Essay Sodium ions (Na^+) and potassium ions (K^+) are needed for the human body to function. Research where these ions are most likely to be found in the body and the roles they play. Write a brief essay describing your findings.

Interactive Textbook

Assessment 9.1 Test yourself on the concepts in Section 9.1.

with ChemASAP

Section 9.1 Assessment

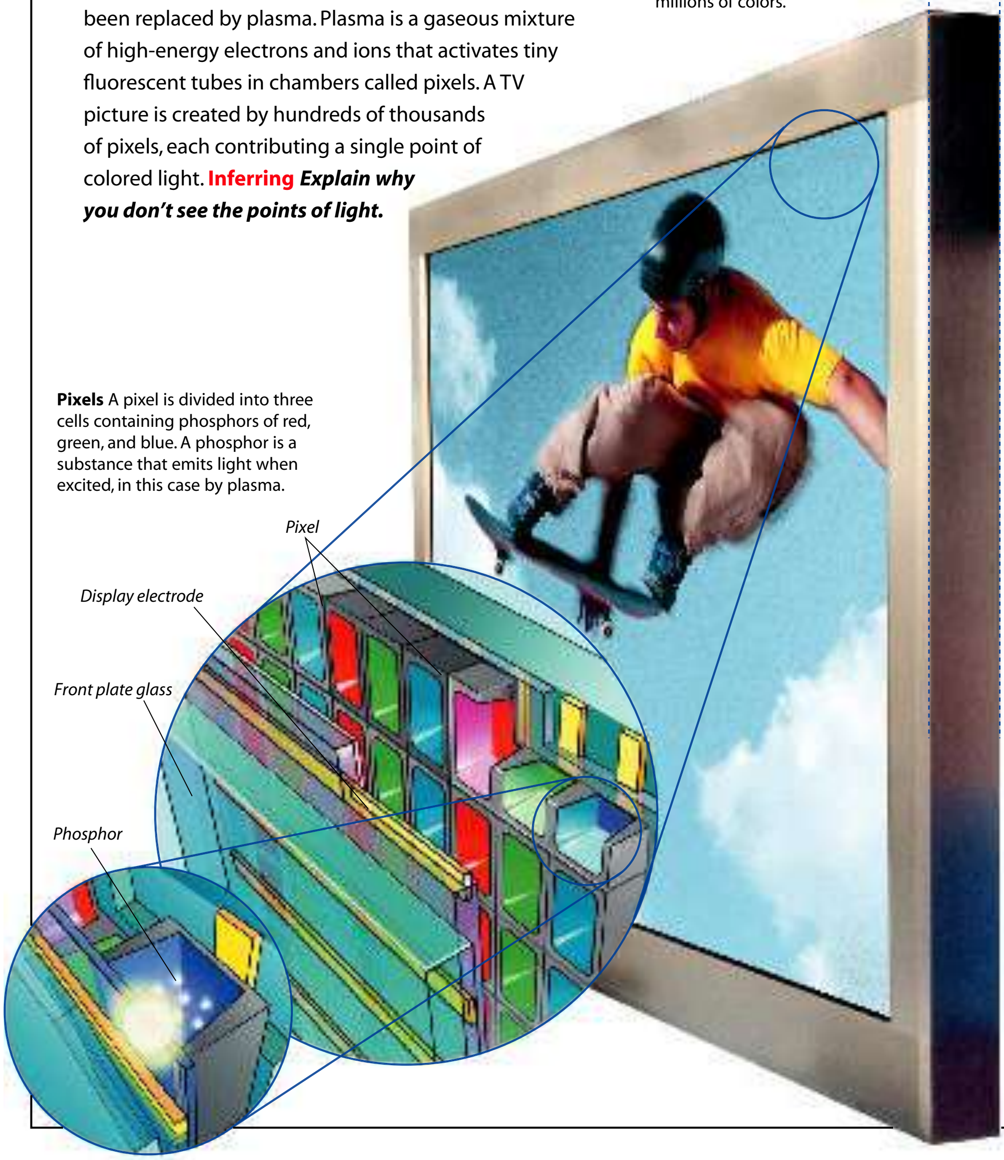
3. The positive charge of a group A metal is equal to its group number. The charge of a group A nonmetal is the group number minus 8.
4. from the number of electrons lost
5. *-ite* or *-ate*
6. Group 1A metals, 1+; Group 3A (aluminum), 3+, Group 5A nonmetals, 3–
7. A monatomic anion is a single atom with a negative charge; a polyatomic anion is two or more bound atoms with a negative charge.
8. **a.** K^+, cation, potassium ion **b.** O^{2-}, anion, oxide ion **c.** Sn^{2+}, cation, tin(II) ion **d.** Br^-, anion, bromide ion **e.** Be^{2+}, cation, beryllium ion **f.** Co^{3+}, cation, cobalt(III) ion
9. **a.** NH_4^+ **b.** Sn^{2+} **c.** CrO_4^{2-} **d.** NO_3^-

Technology & Society

Plasma TV

Today, a TV can be mounted on the wall just as if it were a picture in a frame. The cathode ray tube (CRT), which bulges from the back of a conventional TV, has been replaced by plasma. Plasma is a gaseous mixture of high-energy electrons and ions that activates tiny fluorescent tubes in chambers called pixels. A TV picture is created by hundreds of thousands of pixels, each contributing a single point of colored light. **Inferring** ***Explain why you don't see the points of light.***

How it works A computer controls the output of each pixel individually. Varying the electrical current flowing through the cells changes the intensity of the phosphor color in any cell to create millions of colors.



Pixels A pixel is divided into three cells containing phosphors of red, green, and blue. A phosphor is a substance that emits light when excited, in this case by plasma.

Technology & Society

Plasma TV

Students may be interested in researching one or more of these topics:

- What is the composition of plasma? How is it produced? What is its role in creating a colored TV picture? Are there other ways in which plasma is used today?
- What are the properties of phosphors? What kinds of substances are they and how do they produce light?
- Color theory—how do red, green and blue light produce all imaginable colors of light?
- Plasma is considered a fourth state of matter. Explore the meaning of this statement.
- Explore the quality of plasma TV as compared with conventional TVs. Does the technology of plasma TV assure superior picture quality?

Answers to...

Inferring They are too small.