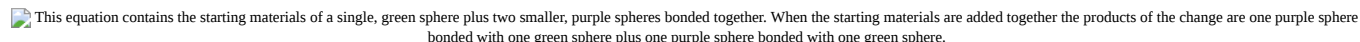


2.E: Atoms, Molecules, and Ions (Exercises)

2.E.1: 2.1: Early Ideas in Atomic Theory

In the following drawing, the green spheres represent atoms of a certain element. The purple spheres represent atoms of another element. If the spheres of different elements touch, they are part of a single unit of a compound. The following chemical change represented by these spheres may violate one of the ideas of Dalton's atomic theory. Which one?

 This equation contains the starting materials of a single, green sphere plus two smaller, purple spheres bonded together. When the starting materials are added together the products of the change are one purple sphere bonded with one green sphere plus one purple sphere bonded with one green sphere.

The starting materials consist of one green sphere and two purple spheres. The products consist of two green spheres and two purple spheres. This violates Dalton's postulate that atoms are not created during a chemical change, but are merely redistributed.

Which postulate of Dalton's theory is consistent with the following observation concerning the weights of reactants and products? When 100 grams of solid calcium carbonate is heated, 44 grams of carbon dioxide and 56 grams of calcium oxide are produced.

Identify the postulate of Dalton's theory that is violated by the following observations: 59.95% of one sample of titanium dioxide is titanium; 60.10% of a different sample of titanium dioxide is titanium.

This statement violates Dalton's fourth postulate: In a given compound, the numbers of atoms of each type (and thus also the percentage) always have the same ratio.

Samples of compound X, Y, and Z are analyzed, with results shown here.

Compound	Description	Mass of Carbon	Mass of Hydrogen
X	clear, colorless, liquid with strong odor	1.776 g	0.148 g
Y	clear, colorless, liquid with strong odor	1.974 g	0.329 g
Z	clear, colorless, liquid with strong odor	7.812 g	0.651 g

Do these data provide example(s) of the law of definite proportions, the law of multiple proportions, neither, or both? What do these data tell you about compounds X, Y, and Z?

2.E.2: 2.2: Evolution of Atomic Theory

2.E.3: Exercises

- The existence of isotopes violates one of the original ideas of Dalton's atomic theory. Which one?
- How are electrons and protons similar? How are they different?
- How are protons and neutrons similar? How are they different?
- Predict and test the behavior of α particles fired at a "plum pudding" model atom.
 - Predict the paths taken by α particles that are fired at atoms with a Thomson's plum pudding model structure. Explain why you expect the α particles to take these paths.
 - If α particles of higher energy than those in (a) are fired at plum pudding atoms, predict how their paths will differ from the lower-energy α particle paths. Explain your reasoning.
 - Now test your predictions from (a) and (b). Open the [Rutherford Scattering simulation](#) and select the "Plum Pudding Atom" tab. Set "Alpha Particles Energy" to "min," and select "show traces." Click on the gun to start firing α particles. Does this match your prediction from (a)? If not, explain why the actual path would be that shown in the simulation. Hit the pause button, or "Reset All." Set "Alpha Particles Energy" to "max," and start firing α particles. Does this match your prediction from (b)? If not, explain the effect of increased energy on the actual paths as shown in the simulation.
- Predict and test the behavior of α particles fired at a Rutherford atom model.

- Predict the paths taken by α particles that are fired at atoms with a Rutherford atom model structure. Explain why you expect the α particles to take these paths.
- If α particles of higher energy than those in (a) are fired at Rutherford atoms, predict how their paths will differ from the lower-energy α particle paths. Explain your reasoning.
- Predict how the paths taken by the α particles will differ if they are fired at Rutherford atoms of elements other than gold. What factor do you expect to cause this difference in paths, and why?
- Now test your predictions from (a), (b), and (c). Open the [Rutherford Scattering simulation](#) and select the “Rutherford Atom” tab. Due to the scale of the simulation, it is best to start with a small nucleus, so select “20” for both protons and neutrons, “min” for energy, show traces, and then start firing α particles. Does this match your prediction from (a)? If not, explain why the actual path would be that shown in the simulation. Pause or reset, set energy to “max,” and start firing α particles. Does this match your prediction from (b)? If not, explain the effect of increased energy on the actual path as shown in the simulation. Pause or reset, select “40” for both protons and neutrons, “min” for energy, show traces, and fire away. Does this match your prediction from (c)? If not, explain why the actual path would be that shown in the simulation. Repeat this with larger numbers of protons and neutrons. What generalization can you make regarding the type of atom and effect on the path of α particles? Be clear and specific.

2.E.3.1: Solutions

1 Dalton originally thought that all atoms of a particular element had identical properties, including mass. Thus, the concept of isotopes, in which an element has different masses, was a violation of the original idea. To account for the existence of isotopes, the second postulate of his atomic theory was modified to state that atoms of the same element must have identical chemical properties.

2 Both are subatomic particles that reside in an atom’s nucleus. Both have approximately the same mass. Protons are positively charged, whereas neutrons are uncharged.

3 Both are subatomic particles that reside in an atom’s nucleus. Both have approximately the same mass. Protons are positively charged, whereas neutrons are uncharged.

4. (a) The plum pudding model indicates that the positive charge is spread uniformly throughout the atom, so we expect the α particles to (perhaps) be slowed somewhat by the positive-positive repulsion, but to follow straight-line paths (i.e., not to be deflected) as they pass through the atoms. (b) Higher-energy α particles will be traveling faster (and perhaps slowed less) and will also follow straight-line paths through the atoms. (c) The α particles followed straight-line paths through the plum pudding atom. There was no apparent slowing of the α particles as they passed through the atoms.

5. (a) The Rutherford atom has a small, positively charged nucleus, so most α particles will pass through empty space far from the nucleus and be undeflected. Those α particles that pass near the nucleus will be deflected from their paths due to positive-positive repulsion. The more directly toward the nucleus the α particles are headed, the larger the deflection angle will be. (b) Higher-energy α particles that pass near the nucleus will still undergo deflection, but the faster they travel, the less the expected angle of deflection. (c) If the nucleus is smaller, the positive charge is smaller and the expected deflections are smaller—both in terms of how closely the α particles pass by the nucleus undeflected and the angle of deflection. If the nucleus is larger, the positive charge is larger and the expected deflections are larger—more α particles will be deflected, and the deflection angles will be larger. (d) The paths followed by the α particles match the predictions from (a), (b), and (c).

2.E.4: 2.3: Atomic Structure and Symbolism

In what way are isotopes of a given element always different? In what way(s) are they always the same?

Write the symbol for each of the following ions:

- (a) the ion with a $1+$ charge, atomic number 55, and mass number 133
- (b) the ion with 54 electrons, 53 protons, and 74 neutrons
- (c) the ion with atomic number 15, mass number 31, and a $3-$ charge
- (d) the ion with 24 electrons, 30 neutrons, and a $3+$ charge

1.

(a) $^{133}\text{Cs}^+$; (b) $^{127}\text{I}^-$; (c) $^{31}\text{P}^{3-}$; (d) $^{57}\text{Co}^{3+}$

Write the symbol for each of the following ions:

- (a) the ion with a $3+$ charge, 28 electrons, and a mass number of 71

2. (b) the ion with 36 electrons, 35 protons, and 45 neutrons
3. (c) the ion with 86 electrons, 142 neutrons, and a 4+ charge
4. (d) the ion with a 2+ charge, atomic number 38, and mass number 87

Open the [Build an Atom simulation](#) and click on the Atom icon.

1. (a) Pick any one of the first 10 elements that you would like to build and state its symbol.
2. (b) Drag protons, neutrons, and electrons onto the atom template to make an atom of your element. State the numbers of protons, neutrons, and electrons in your atom, as well as the net charge and mass number.
3. (c) Click on “Net Charge” and “Mass Number,” check your answers to (b), and correct, if needed.
4. (d) Predict whether your atom will be stable or unstable. State your reasoning.
5. (e) Check the “Stable/Unstable” box. Was your answer to (d) correct? If not, first predict what you can do to make a stable atom of your element, and then do it and see if it works. Explain your reasoning.

(a) Carbon-12, ^{12}C ; (b) This atom contains six protons and six neutrons. There are six electrons in a neutral ^{12}C atom. The net charge of such a neutral atom is zero, and the mass number is 12. (c) The preceding answers are correct. (d) The atom will be stable since C-12 is a stable isotope of carbon. (e) The preceding answer is correct. Other answers for this exercise are possible if a different element of isotope is chosen.

Open the [Build an Atom simulation](#)

(a) Drag protons, neutrons, and electrons onto the atom template to make a neutral atom of Oxygen-16 and give the isotope symbol for this atom.

(b) Now add two more electrons to make an ion and give the symbol for the ion you have created.

Open the [Build an Atom simulation](#)

(a) Drag protons, neutrons, and electrons onto the atom template to make a neutral atom of Lithium-6 and give the isotope symbol for this atom.

(b) Now remove one electron to make an ion and give the symbol for the ion you have created.

(a) Lithium-6 contains three protons, three neutrons, and three electrons. The isotope symbol is ^6Li or ^6_3Li . (b) $^6\text{Li}^+$ or $^6_3\text{Li}^+$

Determine the number of protons, neutrons, and electrons in the following isotopes that are used in medical diagnoses:

- (a) atomic number 9, mass number 18, charge of 1–
- (b) atomic number 43, mass number 99, charge of 7+
- (c) atomic number 53, atomic mass number 131, charge of 1–
- (d) atomic number 81, atomic mass number 201, charge of 1+
- (e) Name the elements in parts (a), (b), (c), and (d).

The following are properties of isotopes of two elements that are essential in our diet. Determine the number of protons, neutrons and electrons in each and name them.

- (a) atomic number 26, mass number 58, charge of 2+
- (b) atomic number 53, mass number 127, charge of 1–
- (a) Iron, 26 protons, 24 electrons, and 32 neutrons; (b) iodine, 53 protons, 54 electrons, and 74 neutrons

Give the number of protons, electrons, and neutrons in neutral atoms of each of the following isotopes:

- (a) $^{10}_5\text{B}$
- (b) $^{199}_{80}\text{Hg}$
- (c) $^{63}_{29}\text{Cu}$
- (d) $^{13}_6\text{C}$
- (e) $^{77}_{34}\text{Se}$

Give the number of protons, electrons, and neutrons in neutral atoms of each of the following isotopes:

- (a) ${}^7_3\text{Li}$
- (b) ${}^{125}_{52}\text{Te}$
- (c) ${}^{109}_{47}\text{Ag}$
- (d) ${}^{15}_7\text{N}$
- (e) ${}^{31}_{15}\text{P}$

(a) 3 protons, 3 electrons, 4 neutrons; (b) 52 protons, 52 electrons, 73 neutrons; (c) 47 protons, 47 electrons, 62 neutrons; (d) 7 protons, 7 electrons, 8 neutrons; (e) 15 protons, 15 electrons, 16 neutrons

Click on the [site](#) and select the “Mix Isotopes” tab, hide the “Percent Composition” and “Average Atomic Mass” boxes, and then select the element boron.

- (a) Write the symbols of the isotopes of boron that are shown as naturally occurring in significant amounts.
- (b) Predict the relative amounts (percentages) of these boron isotopes found in nature. Explain the reasoning behind your choice.
- (c) Add isotopes to the black box to make a mixture that matches your prediction in (b). You may drag isotopes from their bins or click on “More” and then move the sliders to the appropriate amounts.
- (d) Reveal the “Percent Composition” and “Average Atomic Mass” boxes. How well does your mixture match with your prediction? If necessary, adjust the isotope amounts to match your prediction.
- (e) Select “Nature’s” mix of isotopes and compare it to your prediction. How well does your prediction compare with the naturally occurring mixture? Explain. If necessary, adjust your amounts to make them match “Nature’s” amounts as closely as possible.

Repeat [Exercise](#) using an element that has three naturally occurring isotopes.

Let us use neon as an example. Since there are three isotopes, there is no way to be sure to accurately predict the abundances to make the total of 20.18 amu average atomic mass. Let us guess that the abundances are 9% Ne-22, 91% Ne-20, and only a trace of Ne-21. The average mass would be 20.18 amu. Checking the nature’s mix of isotopes shows that the abundances are 90.48% Ne-20, 9.25% Ne-22, and 0.27% Ne-21, so our guessed amounts have to be slightly adjusted.

An element has the following natural abundances and isotopic masses: 90.92% abundance with 19.99 amu, 0.26% abundance with 20.99 amu, and 8.82% abundance with 21.99 amu. Calculate the average atomic mass of this element.

Average atomic masses listed by IUPAC are based on a study of experimental results. Bromine has two isotopes ${}^{79}\text{Br}$ and ${}^{81}\text{Br}$, whose masses (78.9183 and 80.9163 amu) and abundances (50.69% and 49.31%) were determined in earlier experiments. Calculate the average atomic mass of bromine based on these experiments.

79.904 amu

Variations in average atomic mass may be observed for elements obtained from different sources. Lithium provides an example of this. The isotopic composition of lithium from naturally occurring minerals is 7.5% ${}^6\text{Li}$ and 92.5% ${}^7\text{Li}$, which have masses of 6.01512 amu and 7.01600 amu, respectively. A commercial source of lithium, recycled from a military source, was 3.75% ${}^6\text{Li}$ (and the rest ${}^7\text{Li}$). Calculate the average atomic mass values for each of these two sources.

The average atomic masses of some elements may vary, depending upon the sources of their ores. Naturally occurring boron consists of two isotopes with accurately known masses (${}^{10}\text{B}$, 10.0129 amu and ${}^{11}\text{B}$, 11.0931 amu). The actual atomic mass of boron can vary from 10.807 to 10.819, depending on whether the mineral source is from Turkey or the United States. Calculate the percent abundances leading to the two values of the average atomic masses of boron from these two countries.

Turkey source: 0.2649 (of 10.0129 amu isotope); US source: 0.2537 (of 10.0129 amu isotope)

The ${}^{18}\text{O}$: ${}^{16}\text{O}$ abundance ratio in some meteorites is greater than that used to calculate the average atomic mass of oxygen on earth. Is the average mass of an oxygen atom in these meteorites greater than, less than, or equal to that of a terrestrial oxygen atom?

2.E.5: 2.4: Chemical Formulas


Explain why the symbol for an atom of the element oxygen and the formula for a molecule of oxygen differ.

The symbol for the element oxygen, O, represents both the element and one atom of oxygen. A molecule of oxygen, O_2 , contains two oxygen atoms; the subscript 2 in the formula must be used to distinguish the diatomic molecule from two single oxygen atoms.


Explain why the symbol for the element sulfur and the formula for a molecule of sulfur differ.

Write the molecular and empirical formulas of the following compounds:

(a)

 Figure A shows a carbon atom that forms two, separate double bonds with two oxygen atoms.


(b)

 Figure B shows a hydrogen atom which forms a single bond with a carbon atom. The carbon atom forms a triple bond with another carbon atom. The second carbon atom forms a single bond with a hydrogen atom.

(c)

 Figure C shows a carbon atom forming a double bond with another carbon atom. Each carbon atom forms a single bond with two hydrogen atoms.


(d)

 Figure D shows a sulfur atom forming single bonds with four oxygen atoms. Two of the oxygen atoms form a single bond with a hydrogen atom.


(a) molecular CO_2 , empirical CO_2 ; (b) molecular C_2H_2 , empirical CH ; (c) molecular C_2H_4 , empirical CH_2 ; (d) molecular H_2SO_4 , empirical H_2SO_4

Write the molecular and empirical formulas of the following compounds:

(a)

 Figure A shows a structural diagram of four carbon atoms bonded together into a chain. The two carbon atoms on the left form a double bond with each other. All of the remaining carbon atoms form single bonds with each other. The leftmost carbon also forms single bonds with two hydrogen. The second carbon in the chain forms a single bond with a hydrogen atom. The third carbon in the chain forms a single bond with two hydrogen atoms each. The rightmost carbon forms a single bond with three hydrogen atoms each.


(b)

 Figure B shows a structural diagram of a molecule that has a chain of four carbon atoms. The leftmost carbon atom forms a single bond with three hydrogen atoms each and single bond with the second carbon atom. The second carbon atom forms a triple bond with the third carbon atom. The third carbon atom forms a single bond to the fourth carbon atom. The fourth carbon atom forms a single bond to three hydrogen atoms each.

(c)

 Figure C shows a structural diagram of two silicon atoms are bonded together with a single bond. Each of the silicon atoms form single bonds to two chlorine atoms each and one hydrogen atom.

(d)

 Figure D shows a structural diagram of a phosphorus atom that forms a single bond to four oxygen atoms each. Three of the oxygen atoms each have a single bond to a hydrogen atom.

Determine the empirical formulas for the following compounds:


- (a) caffeine, $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$
 - (b) fructose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$
 - (c) hydrogen peroxide, H_2O_2
 - (d) glucose, $\text{C}_6\text{H}_{12}\text{O}_6$
 - (e) ascorbic acid (vitamin C), $\text{C}_6\text{H}_8\text{O}_6$
- (a) $\text{C}_4\text{H}_5\text{N}_2\text{O}$; (b) $\text{C}_{12}\text{H}_{22}\text{O}_{11}$; (c) HO ; (d) CH_2O ; (e) $\text{C}_3\text{H}_4\text{O}_3$

Determine the empirical formulas for the following compounds:


- (a) acetic acid, $\text{C}_2\text{H}_4\text{O}_2$
- (b) citric acid, $\text{C}_6\text{H}_8\text{O}_7$
- (c) hydrazine, N_2H_4
- (d) nicotine, $\text{C}_{10}\text{H}_{14}\text{N}_2$
- (e) butane, C_4H_{10}

Write the empirical formulas for the following compounds:

(a)

 Figure A shows a structural diagram of two carbon atoms that form a single bond with each other. The left carbon atom forms single bonds with hydrogen atoms each. The right carbon forms a double bond to an oxygen atom. The right carbon also forms a single bond to another oxygen atom. This oxygen atom also forms a single bond to a hydrogen atom.

(b)

 Figure B shows a structural diagram containing a leftmost carbon that forms single bonds to three hydrogen atoms each. This leftmost carbon also forms a single bond to a second carbon atom. The second carbon atom forms a double bond with an oxygen atom. The second carbon also forms a single bond to a second oxygen atom. This oxygen atom forms a single bond to a third carbon atom. This third carbon atom forms single bonds with two hydrogen atoms each as well as a single bond with another carbon atom. The rightmost carbon atom forms a single bond with three hydrogen atoms each.

(a) CH_2O ; (b) $\text{C}_2\text{H}_4\text{O}$


Open the [Build a Molecule simulation](#) and select the “Larger Molecules” tab. Select an appropriate atoms “Kit” to build a molecule with two carbon and six hydrogen atoms. Drag atoms into the space above the “Kit” to make a molecule. A name will appear when you have made an actual molecule that exists (even if it is not the one you want). You can use the scissors tool to separate atoms if you would like to change the connections. Click on “3D” to see the molecule, and look at both the space-filling and ball-and-stick possibilities.

1. (a) Draw the structural formula of this molecule and state its name.
2. (b) Can you arrange these atoms in any way to make a different compound?


Use the [Build a Molecule simulation](#) to repeat [Exercise](#), but build a molecule with two carbons, six hydrogens, and one oxygen.

1. (a) Draw the structural formula of this molecule and state its name.
2. (b) Can you arrange these atoms to make a different molecule? If so, draw its structural formula and state its name.
3. (c) How are the molecules drawn in (a) and (b) the same? How do they differ? What are they called (the type of relationship between these molecules, not their names).

(a) ethanol

 A Lewis Structure is shown. An oxygen atom is bonded to a hydrogen atom and a carbon atom. The carbon atom is bonded to two hydrogen atoms and another carbon atom. That carbon atom is bonded to three more hydrogen atoms. There are a total of two carbon atoms, six hydrogen atoms, and one oxygen atom.

(b) methoxymethane, more commonly known as dimethyl ether

 A Lewis Structure is shown. An oxygen atom is bonded to two carbon atoms. Each carbon atom is bonded to three different hydrogen atoms. There are a total of two carbon atoms, six hydrogen atoms, and one oxygen atom.

(c) These molecules have the same chemical composition (types and number of atoms) but different chemical structures. They are structural isomers.

Use the [Build a Molecule simulation](#) to repeat [Exercise](#), but build a molecule with three carbons, seven hydrogens, and one chlorine.

- a. Draw the structural formula of this molecule and state its name.
- b. Can you arrange these atoms to make a different molecule? If so, draw its structural formula and state its name.
- c. How are the molecules drawn in (a) and (b) the same? How do they differ? What are they called (the type of relationship between these molecules, not their names)?

2.E.6: 2.5: The Periodic Table

Using the periodic table, classify each of the following elements as a metal or a nonmetal, and then further classify each as a main-group (representative) element, transition metal, or inner transition metal:

- a. uranium
- b. bromine
- c. strontium
- d. neon
- e. gold
- f. americium
- g. rhodium
- h. sulfur
- i. carbon
- j. potassium

(a) metal, inner transition metal; (b) nonmetal, representative element; (c) metal, representative element; (d) nonmetal, representative element; (e) metal, transition metal; (f) metal, inner transition metal; (g) metal, transition metal; (h) nonmetal, representative element; (i) nonmetal, representative element; (j) metal, representative element

Using the periodic table, classify each of the following elements as a metal or a nonmetal, and then further classify each as a main-group (representative) element, transition metal, or inner transition metal:

1. (a) cobalt
2. (b) europium

3. (c) iodine
4. (d) indium
5. (e) lithium
6. (f) oxygen
7. (g) cadmium
8. (h) terbium
9. (i) rhenium

Using the periodic table, identify the lightest member of each of the following groups:

1. (a) noble gases
2. (b) alkaline earth metals
3. (c) alkali metals
4. (d) chalcogens

(a) He; (b) Be; (c) Li; (d) O

Using the periodic table, identify the heaviest member of each of the following groups:

1. (a) alkali metals
2. (b) chalcogens
3. (c) noble gases
4. (d) alkaline earth metals

1. Use the periodic table to give the name and symbol for each of the following elements:

2. (a) the noble gas in the same period as germanium
3. (b) the alkaline earth metal in the same period as selenium
4. (c) the halogen in the same period as lithium
5. (d) the chalcogen in the same period as cadmium

(a) krypton, Kr; (b) calcium, Ca; (c) fluorine, F; (d) tellurium, Te

Use the periodic table to give the name and symbol for each of the following elements:

1. (a) the halogen in the same period as the alkali metal with 11 protons
2. (b) the alkaline earth metal in the same period with the neutral noble gas with 18 electrons
3. (c) the noble gas in the same row as an isotope with 30 neutrons and 25 protons
4. (d) the noble gas in the same period as gold

Write a symbol for each of the following neutral isotopes. Include the atomic number and mass number for each.

1. (a) the alkali metal with 11 protons and a mass number of 23
2. (b) the noble gas element with 75 neutrons in its nucleus and 54 electrons in the neutral atom
3. (c) the isotope with 33 protons and 40 neutrons in its nucleus
4. (d) the alkaline earth metal with 88 electrons and 138 neutrons

(a) $^{23}_{11}\text{Na}$; (b) $^{129}_{54}\text{Xe}$; (c) $^{73}_{33}\text{As}$; (d) $^{226}_{88}\text{Ra}$

Write a symbol for each of the following neutral isotopes. Include the atomic number and mass number for each.

1. (a) the chalcogen with a mass number of 125
2. (b) the halogen whose longest-lived isotope is radioactive
3. (c) the noble gas, used in lighting, with 10 electrons and 10 neutrons
4. (d) the lightest alkali metal with three neutrons

2.E.7: 2.6: Molecular and Ionic Compounds

Using the periodic table, predict whether the following chlorides are ionic or covalent: KCl, NCl₃, ICl, MgCl₂, PCl₅, and CCl₄.

Ionic: KCl, MgCl₂; Covalent: NCl₃, ICl, PCl₅, 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:

1. (a) NF_3
2. (b) BaO ,
3. (c) $(\text{NH}_4)_2\text{CO}_3$
4. (d) $\text{Sr}(\text{H}_2\text{PO}_4)_2$
5. (e) IBr
6. (f) Na_2O

(a) covalent; (b) ionic, Ba^{2+} , O^{2-} ; (c) ionic, NH_4^+ , CO_3^{2-} ; (d) ionic, Sr^{2+} , H_2PO_4^- ; (e) covalent; (f) ionic, Na^+ , O^{2-}

For each of the following compounds, state whether it is ionic or covalent, and if it is ionic, write the symbols for the ions involved:

1. (a) KClO_4
2. (b) $\text{MgC}_2\text{H}_3\text{O}_2$
3. (c) H_2S
4. (d) Ag_2S
5. (e) N_2Cl_4
6. (f) $\text{Co}(\text{NO}_3)_2$

For each of the following pairs of ions, write the symbol for the formula of the compound they will form:

1. (a) Ca^{2+} , S^{2-}
2. (b) NH_4^+ , SO_4^{2-}
3. (c) Al^{3+} , Br^-
4. (d) Na^+ , HPO_4^{2-}
5. (e) Mg^{2+} , PO_4^{3-}

(a) CaS ; (b) $(\text{NH}_4)_2\text{CO}_3$; (c) AlBr_3 ; (d) Na_2HPO_4 ; (e) $\text{Mg}_3(\text{PO}_4)_2$

For each of the following pairs of ions, write the symbol for the formula of the compound they will form:

1. (a) K^+ , O^{2-}
2. (b) NH_4^+ , PO_4^{3-}
3. (c) Al^{3+} , O^{2-}
4. (d) Na^+ , CO_3^{2-}
5. (e) Ba^{2+} , PO_4^{3-}

2.E.8: 2.7: Chemical Nomenclature

Name the following compounds:

1. (a) CsCl
2. (b) BaO
3. (c) K_2S
4. (d) BeCl_2
5. (e) HBr
6. (f) AlF_3

(a) cesium chloride; (b) barium oxide; (c) potassium sulfide; (d) beryllium chloride; (e) hydrogen bromide; (f) aluminum fluoride

Name the following compounds:

1. (a) NaF
2. (b) Rb_2O
3. (c) BCl_3
4. (d) H_2Se
5. (e) P_4O_6
6. (f) ICl_3

Write the formulas of the following compounds:

1. (a) rubidium bromide
2. (b) magnesium selenide

3. (c) sodium oxide
4. (d) calcium chloride
5. (e) hydrogen fluoride
6. (f) gallium phosphide
7. (g) aluminum bromide
8. (h) ammonium sulfate

(a) RbBr; (b) MgSe; (c) Na₂O; (d) CaCl₂; (e) HF; (f) GaP; (g) AlBr₃; (h) (NH₄)₂SO₄

Write the formulas of the following compounds:

1. (a) lithium carbonate
2. (b) sodium perchlorate
3. (c) barium hydroxide
4. (d) ammonium carbonate
5. (e) sulfuric acid
6. (f) calcium acetate
7. (g) magnesium phosphate
8. (h) sodium sulfite

Write the formulas of the following compounds:

1. (a) chlorine dioxide
2. (b) dinitrogen tetraoxide
3. (c) potassium phosphide
4. (d) silver(I) sulfide
5. (e) aluminum nitride
6. (f) silicon dioxide

(a) ClO₂; (b) N₂O₄; (c) K₃P; (d) Ag₂S; (e) AlN; (f) SiO₂

Write the formulas of the following compounds:

1. (a) barium chloride
2. (b) magnesium nitride
3. (c) sulfur dioxide
4. (d) nitrogen trichloride
5. (e) dinitrogen trioxide
6. (f) tin(IV) chloride

Each of the following compounds contains a metal that can exhibit more than one ionic charge. Name these compounds:

1. (a) Cr₂O₃
2. (b) FeCl₂
3. (c) CrO₃
4. (d) TiCl₄
5. (e) CoO
6. (f) MoS₂

(a) chromium(III) oxide; (b) iron(II) chloride; (c) chromium(VI) oxide; (d) titanium(IV) chloride; (e) cobalt(II) oxide; (f) molybdenum(IV) sulfide

Each of the following compounds contains a metal that can exhibit more than one ionic charge. Name these compounds:

1. (a) NiCO₃
2. (b) MoO₃
3. (c) Co(NO₃)₂
4. (d) V₂O₅
5. (e) MnO₂
6. (f) Fe₂O₃

The following ionic compounds are found in common household products. Write the formulas for each compound:

1. (a) potassium phosphate
2. (b) copper(II) sulfate
3. (c) calcium chloride
4. (d) titanium dioxide
5. (e) ammonium nitrate
6. (f) sodium bisulfate (the common name for sodium hydrogen sulfate)

(a) K_3PO_4 ; (b) CuSO_4 ; (c) CaCl_2 ; (d) TiO_2 ; (e) NH_4NO_3 ; (f) NaHSO_4

The following ionic compounds are found in common household products. Name each of the compounds:

1. (a) $\text{Ca}(\text{H}_2\text{PO}_4)_2$
2. (b) FeSO_4
3. (c) CaCO_3
4. (d) MgO
5. (e) NaNO_2
6. (f) KI

What are the IUPAC names of the following compounds?

1. (a) manganese dioxide
2. (b) mercurous chloride (Hg_2Cl_2)
3. (c) ferric nitrate [$\text{Fe}(\text{NO}_3)_3$]
4. (d) titanium tetrachloride
5. (e) cupric bromide (CuBr_2)

(a) manganese(IV) oxide; (b) mercury(I) chloride; (c) iron(III) nitrate; (d) titanium(IV) chloride; (e) copper(II) bromide

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