

Conclude and Apply Answers

- Products include iron(III) hydroxide, nickel(III) hydroxide, copper(II) hydroxide, and sodium chloride.
- Test tube A: iron(II) hydroxide
Test tube B: nickel(III) hydroxide
Test tube C: copper(II) hydroxide

■ USING THE FEATURE**National Geographic: Visualizing Polar Molecules, p. 200**

The idea of polarity in molecules is likely to be completely new and possibly unexpected because covalent compounds exist without the presence of ions, since bonding electrons are shared rather than transferred. Explain to students that the atoms of different elements differ in their ability to attract electrons from other atoms. These differences result in uneven sharing of electrons unless the two atoms are the same element. These small differences cause negative regions to be present within a molecule on atoms that are better at pulling electrons (which are negative) towards them. Atoms that are less able to hold electrons become slightly positive. Although the molecule as a whole is neutral, parts may be slightly charged. This imbalance of charge can lead to attractions between molecules that would not otherwise be present.

The most important example of this is water, which is a polar molecule with a negative side at the oxygen and a positive side at the hydrogens. Water is a liquid at room temperature precisely because it is polar. If it were not, the water in our bodies would exist only as a gas at room temperature. Not all covalent compounds are polar. For example, carbon dioxide is not. This is because the two oxygen atoms sit exactly on opposite sides of the carbon atom, and the net polarizing effect of these two atoms exactly cancels out. Notice also that carbon dioxide is a gas at room temperature, not a liquid or solid.

■ SECTION 4.2 ASSESSMENT, p. 201**Check Your Understanding Answers****Checking Concepts**

- The name of the positive ion, the name of the negative ion
 - The name of each non-metal element present as well as the number of atoms in each type of element in the compound
- Multivalent refers to the ability of some metals to form an ion in more than one way.

- Polyatomic refers to the ability of some non-metal atoms to combine to form an ion that contains two or more atoms.
- Ratio of ions refers to how the number of positive and negative ions present exists in a specific ratio in an ionic compound. For example, 2:3 would mean that, for every two positive ions present, there are three negative ions present.

3.

1	mono-
2	di-
3	tri-
4	tetra-
5	penta-
6	hexa-
7	hepta-
8	octa-
9	nona-
10	deca-

- Sodium
 - Sulphate
 - Vanadium(IV)
 - Cyanide
 - Ammonium
 - Oxide
- Positive ion
 - Polyatomic, negative ion
 - Multivalent metal, positive ion
 - Polyatomic, negative ion
 - Polyatomic, positive ion
 - Negative ion
- This chart is also available for students to complete on BLM 2-17, Check Your Understanding Charts.

	Formula	Name	Number of Each Kind of Atom	Total Number of Atoms	Electric Charge on the Ion
(a)	CH_3COO^-	acetate	2 C, 3 H, 2 O	7	1-
(b)	HSO_3^-	hydrogen sulphite	1 H, 1 S, 3 O	5	1-
(c)	PO_4^{3-}	phosphate	1 P, 4 O	5	3-
(d)	CrO_4^{2-}	chromate	1 Cr, 4 O	5	2-
(e)	$\text{Cr}_2\text{O}_7^{2-}$	dichromate	2 Cr, 7 O	9	2-
(f)	MnO_4^-	permanganate	1 Mn, 4 O	5	1-

Understanding Key Ideas

7. (a) NaBr
 (b) CaF₂
 (c) FeBr₃
 (d) AuI
 (e) V₂O₁₀
 (f) MoN
 (g) (NH₄)₃PO₄
 (h) KNO₃
 (i) Mn(ClO₄)₂
8. (a) Lithium fluoride
 (b) Magnesium iodide
 (c) Iron(III) oxide
 (d) Silver nitride
 (e) Gold(I) nitride
 (f) Platinum sulphate
 (g) Ammonium carbonate
 (h) Cesium nitrate
9. (a) SO₂
 (b) ClF
 (c) NI₃
 (d) N₂O
 (e) N₂O₄
 (f) SeF₂
10. (a) Phosphorus pentafluoride
 (b) Tetraphosphorus decaoxide
 (c) Carbon monoxide
 (d) Sulfur hexafluoride
 (e) Xenon trioxide
 (f) Nitrogen dioxide
 (g) Oxygen difluoride
11. This chart is also available for students to complete on BLM 2-17, Check Your Understanding Charts.

	Formula	Ionic or Covalent?	Name of Compound
(a)	Cl ₂ O	covalent	dichlorine monoxide
(b)	CO ₂	covalent	carbon dioxide
(c)	CoO	ionic	cobalt(II) oxide
(d)	CO	covalent	carbon monoxide
(e)	PbO ₂	ionic	lead(IV) oxide
(f)	MgCl ₂	ionic	magnesium chloride
(g)	PtCl ₂	ionic	platinum(II) chloride
(h)	SCl ₂	covalent	sulfur dichloride
(i)	NaCH ₃ COO	ionic	sodium acetate
(j)	NH ₄ CH ₃ COO	ionic	ammonium acetate
(k)	NaHCO ₃	ionic	sodium hydrogen carbonate

Pause and Reflect Answer

Students should cover some of these points.

- Ionic compounds are held together by the attraction of positively charged ions to negatively charged ions.
- Covalent compounds are held together by the attraction of two atoms to the same pair of electrons.
- Ionic compounds form an ionic lattice in which there is no molecule. The smallest part of an ionic compound that retains the properties of the compound is a formula unit.
- Covalent compounds form molecules. Each molecule is a fixed number of atoms held together by covalent bonds and forms the smallest part of a covalent compound that retains the properties of the compound.
- The mind map for writing chemical formulas of each type of compound should contain a summary of the rules given in the text in section 4.2.

Other Assessment Opportunities

- Assessment Checklist 1, Making Observations and Inferences
- Assessment Checklist 25, Safety Checklist
- Process Skills Rubric 1, Developing Models
- Assessment Rubric 5, Conduct an Investigation Rubric
- Assessment Rubric 11, Communication Rubric

4.3 CHEMICAL EQUATIONS**■ BACKGROUND INFORMATION**

The concept of a chemical equation as a notation to describe important aspects of a chemical reaction is developed in this section right after the introduction of chemical formulas. This is so that chemical equations can be used throughout the rest of the unit. It also permits as much time as possible for students to become familiar with equations before they attempt to classify them in Section 6.2.

The idea of a balanced equation goes hand in hand with the law of conservation of mass, and the straightforward but important Find Out Activity 4-3A, Investigating Mass Changes in a Reaction. This activity is very useful for engaging students in what is otherwise a very abstract concept. Note that, due to inevitable student errors, there will be some variation in masses before and after. However, if you direct students to write the difference between the mass after and the mass before, the errors will tend to cancel out.

3. Write Names and Formulas of Compounds

- Compounds that contain a metal or the ammonium ion are ionic, whereas compounds that do not are covalent.
- The chemical name of an ionic compound indicates the two ions present in the compound, of which the positive ion is always given first.
- The chemical formula of an ionic compound shows the ratios of each ion present in the compound.
- The chemical name of a binary covalent compound includes element names and prefixes that indicate the number of each type of atom present in a molecule of the compound.

4. Balance and Explain the Meanings of Chemical Equations

- Chemical equations represent chemical changes by showing the reactants and products in a reaction.
- The law of conservation of mass states that mass is not created or destroyed in a chemical reaction.
- In a balanced chemical equation, the number of atoms of each kind of element is the same on both sides of the equation.

CHAPTER REVIEW ANSWERS

Checking Concepts

1.

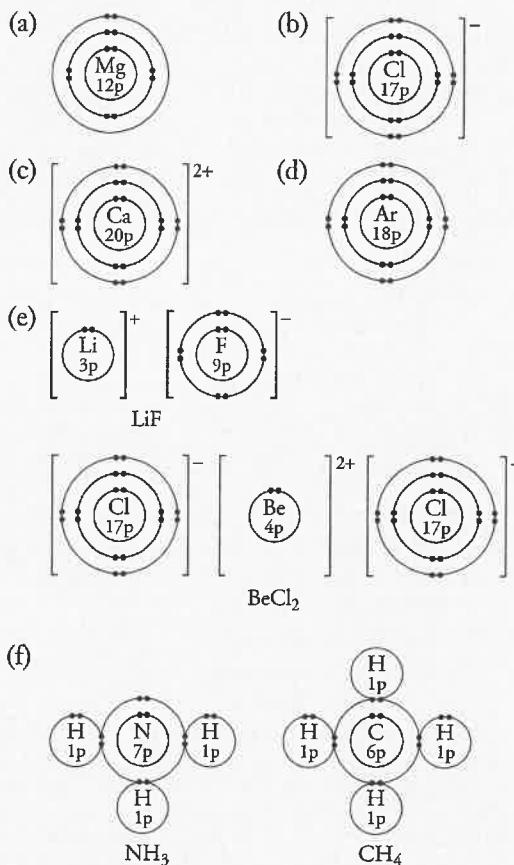
Name of subatomic particle	Proton	Electron	Neutron
Relative mass	1836	1	1837
Charge	+	-	0
Location in the atom	Nucleus	Surrounding nucleus	Nucleus

2. (a) Alkali metals, alkaline earth metals, halogens, noble gases
 (b) 1, 2, 17, and 18, respectively
 (c) Alkali metals: extremely reactive metals
 Alkaline earth metals: somewhat reactive metals
 Halogens: very reactive non-metals
 Noble gases: very unreactive non-metals
3. (a) Metal atoms lose electrons as they become positive ions.
 (b) Non-metal atoms gain electrons as they become negative ions.
4. Stable octet refers to the tendency of atoms to retain eight valence electrons (noble gases) or to gain, lose, or share electrons in order to attain eight valence electrons.

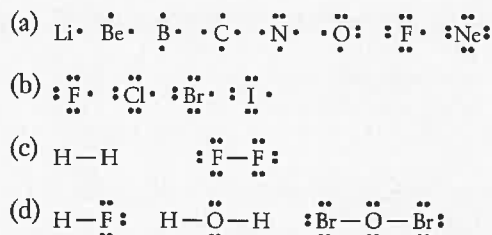
An octet is stable because once an atom or ion has eight valence electrons it becomes chemically less reactive.

5. (a) Multivalent refers to the ability of some metals to form a positive ion in more than one way.
 (b) For example, iron is multivalent as it can form a 2+ or a 3+ ion.
 (c) For example, calcium is not multivalent because it can form only a 2+ ion.
6. (a) Calcium, Ca
 (b) Bromine, Br
 (c) Thallium, Tl
 (d) Lithium, Li
 (e) Helium, He

7.



8.



9. (a) Al
(b) K
(c) Ar
(d) O
10. (a) Ionic, for example: LiF
(b) Ionic, for example: AlN
(c) Covalent, for example: NH₃
(d) Covalent, for example: CF₄
11. The chart for this question is available for students to complete on BLM 2-22, Chapter 4 Review Chart.
(a) Sodium nitride, Na₃N
(b) Magnesium oxide, MgO
(c) Aluminum sulphide, Al₂S₃
(d) Gallium fluoride, GaF₃
(e) Silver selenide, Ag₂Se
(f) Zinc chloride, ZnCl₂
12. (a) AuF₃
(b) Pb₃N₄
(c) CuI
(d) Ni₂S₃
(e) CrO
13. (a) Tin(IV) chloride
(b) Gold(III) nitride
(c) Lead(IV) sulphide
(d) Bismuth(V) oxide
(e) Iron(III) iodide
(f) Uranium(VI) fluoride
14. (a) Na₂CO₃
(b) (NH₄)₃PO₄
(c) NH₄NO₃
(d) Fe(NO₂)₃
(e) Ca(ClO₄)₂
15. (a) Aluminum sulphate
(b) Ammonium acetate
(c) Iron(III) chromate
(d) Sodium dichromate
(e) Potassium cyanide
(f) Lead(II) hydrogen sulphide
16. (a) PCl₅
(b) NCl₃
(c) Si₆
(d) P₄O₁₀
(e) N₂O₃
17. (a) Dinitrogen tetrafluoride
(b) Phosphorus tribromide
(c) Nitrogen tribromide
(d) Carbon dioxide
18. The chart for this question is available for students to complete on BLM 2-22, Chapter 4 Review Chart.
(a) Ionic, calcium chloride
(b) Ionic, copper(II) chloride

- (c) Covalent, sulfur dichloride
(d) Ionic, cobalt(II) sulphide
19. (a) 4 hydrogen, 2 chlorine, 1 calcium, 2 oxygen
(b) 6 sodium, 2 phosphorous, 24 oxygen, 3 calcium, 6 nitrogen
20. (a) $2\text{KCl} + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{PbCl}_2 + 2\text{KNO}_3$
(b) $2\text{Na} + \text{F}_2 \rightarrow 2\text{NaF}$
(c) $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$
(d) $2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$
21. (a) The drop in pressure suggests that some of the oxygen gas reacted with the mercury and formed a new product (such as a solid).
(b) $10.8 \text{ g} \times 10.0 \text{ g} = 0.8 \text{ g}$ of gas was consumed
(c) The new substance might be mercury oxide.

Pause and Reflect Answer

Students' answers may vary but may cover some of these points:

- Compounds are substances that contain two or more elements chemically connected.
- Compounds form as a result of rearrangements of electrons that allow atoms or ions to be held together.
- Compounds exist as ionic (ionic bonds, ionic lattice) and covalent (covalent bonds, molecules).
- Covalent bonds form as valence electrons become shared between two atoms.
- Ionic bonds form as atoms gain or lose electrons (by trading them between atoms) to become ions, which are thereafter attracted to each other due to their opposite charge.