### Word Equations

Reaction 1: magnesium + hydrochloric acid → magnesium chloride + hydrogen
Reaction 2: magnesium sulphate + sodium carbonate → magnesium carbonate + sodium sulphate
Reaction 3: magnesium + copper(II) chloride → magnesium chloride + copper

### Balanced Chemical Equations

Reaction 1: $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
Reaction 2: $MgSO_4(aq) + Na_2CO_3(aq) \rightarrow MgCO_3(s) + Na_2SO_4(aq)$
Reaction 3: $Mg(s) + CuCl_2(aq) \rightarrow MgCl_2(aq) + Cu(s)$

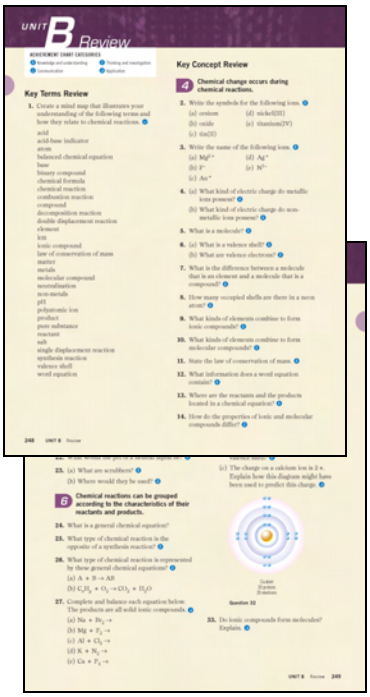
### Extend

Ask students to use the Internet to find applications for the magnesium compounds used or produced in these three chemical reactions.

### Assess the Activity

As students work on this activity, you can assign marks for participation, recording of data, and clean-up. You might wish to assign marks for a written pre-lab or assign marks for the final Unit Task lab report. You may wish to use the Line Masters listed in the margin to help you assess students' work.

***Pages 248–249***




## B Unit Review — ANSWERS TO QUESTIONS

## Key Terms Review

1. Students' mind maps will vary but should show how the terms are connected. For example *acid* and *base* will both connect to *pH* with "low" beside *acid* and "high" beside *base*.

## Key Concept Review

**4**

2. **(a)** $Cs^+$
   **(b)** $O^{2-}$
   **(c)** $Sn^{2+}$
   **(d)** $Ni^{3+}$
   **(e)** $Ti^{4+}$
3. **(a)** magnesium
   **(b)** fluoride
   **(c)** gold(I)
   **(d)** silver
   **(e)** nitride
4. **(a)** Metal ions have positive charges.
   **(b)** Non-metal ions have negative charges.
5. A molecule is a combination of two or more atoms held together by covalent bonds.

**6.** **(a)** The valence shell is the outermost shell of an atom.
**(b)** Electrons in the valence shell are called valence electrons.

**7.** A molecule of an element, such as $O_2$, is composed of only one type of atom. A molecule of a compound, such as $H_2O$, is composed of different elements.

**8.** A neon atom has two energy shells, and they are both entirely filled with electrons.

**9.** Metals combine with non-metals or with non-metal polyatomic ions to form ionic compounds.

**10.** Non-metals combine with other non-metals or with non-metal polyatomic ions to form molecular compounds.

**11.** The law of conservation of mass states that the total mass of the products in a chemical reaction is always equal to the total mass of the reactants.

**12.** A word equation tells you the names of the reactants and the products of a chemical reaction.

**13.** The reactants in a chemical equation are located on the left side of the arrow. The products in a chemical equation are located on the right side of the arrow.

**14.** Ionic compounds have these properties.

- At room temperature, most are hard, brittle solids that can be crushed.
- They form crystals.
- Ionic crystals have very high melting points.
- When ionic compounds dissolve in water, the solutions conduct electricity.

The properties of molecular compounds are as follows:

- They are often soft.
- If they dissolve in water, they form solutions that do not conduct electricity.
- They tend to have relatively low melting points.

## 5

**15.** The range of numbers on the pH scale is 1 to 14.

**16.** The pH range of bases is 7.1 to 14.

**17.** The pH range of acids is 0 to 6.9.

**18.** The reactants in a neutralization reaction are an acid and a base.

**19.** An ionic compound called a salt is produced in a neutralization reaction.

**20.** You can identify the formula of an acid if it starts with H (hydrogen) or ends in COOH (carboxyl). You can identify the formula for a base if the chemical formula starts with a metallic ion or with the ammonium ion, $NH_4^+$, and ends with OH (called a hydroxyl group).

**21.** Acid precipitation is rain, snow, fog, or dew that has a pH of less than 5.6. (Rain usually has a pH of around 5.6.)

**22.** The pH of a neutral liquid would be 7.0.

**23.** **(a)** Scrubbers are devices that remove sulphur dioxide gas or nitrogen oxides from industrial emissions.

**(b)** Scrubbers would be used inside the smokestacks of any industry that produces sulphur dioxide gas or nitrogen oxide gases as a by-product of their industrial processes.

## 6

**24.** A general chemical equation (GCE) is an equation that uses letters of the alphabet (A, B, C, D, X), as well as some element symbols, to represent different chemical reactions.

**25.** The opposite of a synthesis reaction is a decomposition reaction.

**26.** **(a)** synthesis

**(b)** combustion

**27.** **(a)** $2Na + Br_2 \rightarrow 2NaBr$

This is now balanced correctly.

**(b)** $Mg + F_2 \rightarrow MgF_2$

**(c)** $2Al + 3Cl_2 \rightarrow 2AlCl_3$

**(d)** $6K + N_2 \rightarrow 2K_3N$

**(e)** $6Ca + P_4 \rightarrow 2Ca_3P_2$

**28.** A single displacement reaction will occur.

**29.** This is a combustion reaction.

### Connect Your Understanding

**30.** Students' answers will vary but may include lithium, calcium, and magnesium.

**31.** Students' answers will vary but may include oxygen ($O^{2-}$), bromine ($Br^-$) and sulphur ($S^{2-}$).

**32.** **(a)** There are four shells.

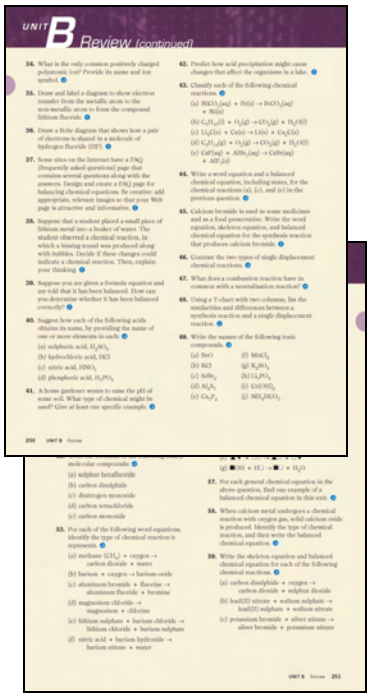
**(b)** There are two valence electrons.

**(c)** The charge on a metal ion represents the number of electrons in the outer shell that are pulled away when the ion combines with a non-metal ion to produce a compound. Since the valence shell contains two electrons, a calcium ion would lose two electrons, creating a calcium ion, $Ca^{2+}$.

**33.** Ionic compounds do not form molecules. Instead, they form a lattice of ions in which every ion is attracted to every other ion. Ionic compounds do not contain covalent bonds, which are necessary for a molecule to form.

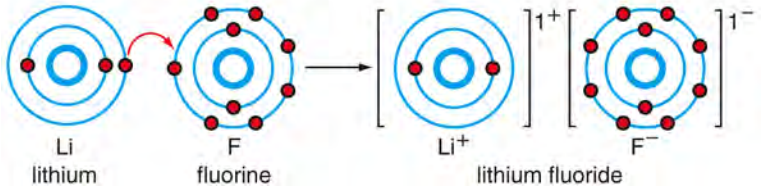
**34.** Ammonium, $NH_4^+$, is the only common positively charged polyatomic ion.

***Pages 250–251***



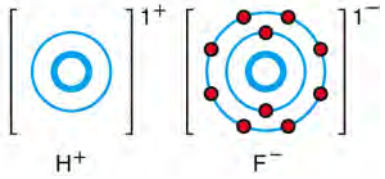
**35.**

**Bohr Diagrams for the Creation of Lithium Fluoride**




**36.**

**Bohr Diagram of Hydrogen Fluoride**




**37.** Students' FAQ pages will vary but might include the following questions.
What is a balanced chemical reaction?
What symbols are used to indicate the state of matter in a balanced chemical reaction?
What is a coefficient?
What is a subscript?
What are the six types of chemical reactions?

**38.** Yes, these could indicate a chemical reaction because the production of sound (hissing) and the production of a gas (bubbles) are two indications of a chemical reaction taking place.

**39.** In order to verify that the equation has been balanced correctly, you can check to see if the numbers of atoms of each element are the same on both sides of the equation.

**40.** The name of each acid comes from:
**(a)** sulphur
**(b)** hydrogen, chlorine
**(c)** nitrogen
**(d)** phosphorus

**41.** Raising the pH of soil requires a base. Examples of bases that could be used are calcium carbonate (lime) and calcium hydroxide (slaked lime).

**42.** Acid precipitation adds acid to the lake, which lowers the pH of the water. As the pH continues to fall, more lake organisms die because the water's pH is beyond the pH range that the organisms can tolerate.

**43.** The reactions are:

**(a)** single displacement reaction
**(b)** combustion reaction
**(c)** single displacement reaction
**(d)** combustion reaction
**(e)** double displacement reaction

**44. (a)** word equation: nickel(II) carbonate + iron → iron(II) carbonate + nickel
balanced equation: $NiCO_3(aq) + Fe(s) \rightarrow FeCO_3(aq) + Ni(s)$

**(c)** word equation: lithium carbide + calcium → lithium + calcium carbide
balanced equation: $Li_4C(s) + 2Ca(s) \rightarrow 4Li(s) + Ca_2C(s)$

**(e)** word equation: cesium fluoride + aluminum bromide → cesium bromide + aluminum fluoride
balanced equation: $3CsF(aq) + AlBr_3(aq) \rightarrow 3CsBr(aq) + AlF_3(s)$

**45.** word equation: calcium + bromine → calcium bromide
skeleton equation: $Ca + Br_2 \rightarrow CaBr_2$
balanced equation: $Ca + Br_2 \rightarrow CaBr_2$

**46.** There are two types of single-displacement chemical reactions. In the first type, a metal element displaces a metal element in an ionic compound. In the second type, a non-metal element displaces a non-metal element in a molecular compound.

**47.** In both a combustion reaction and a neutralization reaction, water ($H_2O$) is produced.

**48.** Comparing the similarities and differences between a synthesis reaction and a single displacement reaction.

| Similarities | Differences |
|---|---|
| There are two reactants in both types of reactions. | A synthesis reaction has a single product: a compound. A single displacement reaction has two products: an element and a compound. |
| Mass is conserved in both types of reactions. | There are two types of single displacement reactions, one for a metal and one for a non-metal. |
| The number of each kind of atom is conserved. | |
| Both reactions have a compound on the products side. | |

**49.** **(a)** beryllium oxide
**(b)** potassium chloride
**(c)** strontium bromide
**(d)** aluminum sulphide
**(e)** calcium phosphide
**(f)** manganese(II) chloride
**(g)** potassium sulphate
**(h)** lithium phosphate
**(i)** chromium(II) hydroxide
**(j)** ammonium hydrogen carbonate

**50.** **(a)** NaBr
**(b)** $Be_3P_2$
**(c)** $Cu_2O$
**(d)** $Pd(NO_3)_4$
**(e)** $(NH_4)_2SO_4$
**(f)** $NH_4NO_3$

**51.** **(a)** disulphur trioxide
**(b)** diphosphorus pentasulphide
**(c)** oxygen difluoride
**(d)** dinitrogen trioxide
**(e)** carbon dioxide

**52.** **(a)** $SF_6$
**(b)** $CS_2$
**(c)** $N_2O$
**(d)** $CCl_4$
**(e)** CO

**53.** **(a)** combustion reaction
**(b)** synthesis reaction
**(c)** single displacement reaction
**(d)** decomposition reaction
**(e)** double displacement reaction
**(f)** neutralization reaction

**54.** $HCl + KOH \rightarrow KCl + H_2O$

**55.** Students' answers will vary. An example would be one player going into a basketball game to relieve another player who is tired.

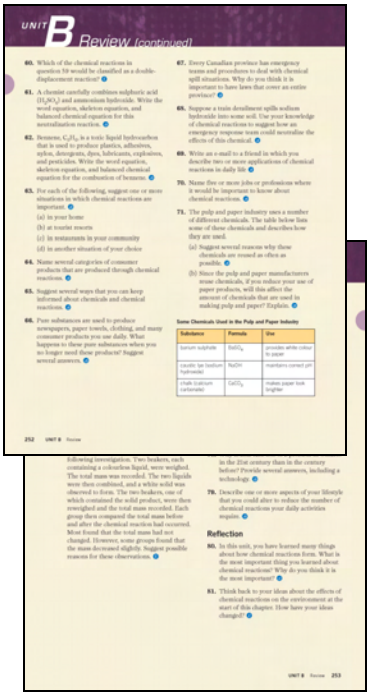
**56.** **(a)** single displacement reaction
**(b)** neutralization reaction
**(c)** decomposition reaction
**(d)** single displacement reaction
**(e)** synthesis reaction
**(f)** double displacement reaction
**(g)** neutralization reaction

**57.** Students' examples will vary but may include the reactions listed below. Note that only five of the six types of chemical reactions are represented in question 56. Combustion is absent but is included below.
synthesis reaction: p. 225 — $3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$
decomposition reaction: p. 226 — $2HgO(s) \rightarrow 2Hg(l) + O_2(g)$
combustion reaction: p. 232 — $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$
single displacement reaction: p. 233 — $2AgNO_3(aq) + Mg(s) \rightarrow Mg(NO_3)_2(aq) + 2Ag(s)$
double displacement reaction: p. 235 — $Pb(NO_3)_2(aq) + 2NaI(aq) \rightarrow PbI_2(s) + 2NaNO_3(aq)$
neutralization reaction: p. 209 — $2HNO_3(aq) + Ca(OH)_2(s) \rightarrow CaNO_3)_2(aq) + 2H_2O(l)$

**58.** This is a synthesis chemical reaction. The balanced chemical equation is: $2Ca + O_2 \rightarrow 2CaO$.

**59.** **(a)** $CS_2 + 3O_2 \rightarrow CO_2 + 2SO_2$
**(b)** $Pb(NO_3)_2 + Na_2SO_4 \rightarrow PbSO_4 + 2NaNO_3$
**(c)** $KBr + AgNO_3 \rightarrow AgBr + KNO_3$

***Pages 252–253***


UNIT B Review (continued)

**60.** Reaction (b) in question 59 is a double displacement reaction.

**61.** Word equation: sulphuric acid + ammonium hydroxide → ammonium sulphate + water
Skeleton equation: $H_2SO_4 + NH_4OH \rightarrow (NH_4)_2SO_4 + H_2O$
Balanced chemical equation: $H_2SO_4 + 2NH_4OH \rightarrow (NH_4)_2SO_4 + 2H_2O$

**62.** Word equation: benzene + oxygen → carbon dioxide + water
Skeleton equation: $C_6H_6 + O_2 \rightarrow CO_2 + H_2O$
Balanced chemical equation: $2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$

**63.** Students answers will vary but may include the following.
**(a)** Chemical reactions are important for cooking, taking medicine, cleaning solutions, washing clothes, and gardening.
**(b)** Chemical reactions are important at tourist resorts for cleaning solutions and disinfecting swimming pools.
**(c)** Chemical reactions are important in restaurants for cooking and cleaning.
**(d)** Chemical reactions are important for manufacturing various products including paints and textiles, steel, and ceramics.

**64.** Student answers will vary but may include some of the following categories of consumer products that are produced through chemical reactions: dyes, plastics for electronics, cosmetics, personal care products such as deodorant and toothpaste, and cleaning products.

**65.** You can keep informed about chemicals and chemical reactions by reading the daily newspaper, checking Internet sites, borrowing books from a library, or even asking your science teacher!

**66.** When you no longer need these products, these pure substances usually become waste. Waste can be burned in an incinerator, buried in landfills, or possibly recycled through a municipal recycling program.

**67.** It would pose a danger to human health and the environment if chemical spills were dealt with differently in different parts of the province. Remote regions might not have the expertise or resources to deal with spills properly. This could mean that some people in the province would be more at risk than others, depending on where the spill happened. By having laws that apply to the whole province, no matter where in the province a spill happened, it would have to be cleaned up according to the law. Remote areas that do not have the resources or expertise would get help from other regions in order to follow the laws governing spills. This could save lives and also protect the environment.

**68.** Sodium hydroxide is a base. An emergency response team could neutralize the effects of a sodium hydroxide spill by applying an acid, such as hydrochloric acid, to the soil.

**69.** Students answers will vary but might include the following examples: food preparation (cooking), gardening (pH of soil), painting a house, and digesting food.

**70.** Student answers will vary but might include the following examples of jobs or professions involving knowledge of chemical reactions: environmental chemist, laboratory technician, polymer chemist, chef, and firefighter.

**71.** **(a)** These chemicals are reused as often as possible because they are expensive, so reusing them cuts costs. By reusing them, the industry uses fewer resources to produce paper. Reusing them also cuts down on the amount waste requiring treatment as well as the cost of buying and transporting replacement chemicals.

**(b)** Yes. If you reduce your use of paper products, this will reduce the demand for paper and so reduce the amount of chemicals (and trees) used to make pulp and paper, as well as reducing the energy used to transport raw materials and finished paper products.

**72.** A career in chemistry or chemical engineering can be rewarding because you could produce new products (such as medicines) that help people. You could find ways to reduce damage to the environment, or you could find ways to treat waste or toxic materials.

**73.** In order to decide whether to allow the facility to be located in your community, you would need to know how raw materials (such as chemicals) would be brought to the factory safely, what kinds of chemicals would be used, what waste chemical products there would be, and how they would be handled.

## Skills Practice

**74.** Students' procedures might include an indicator solution, pH paper, or a pH meter. A sample procedure, using pH paper, is as follows.

**Procedure**

1. Put on rubber gloves, safety glasses, and a lab apron.
2. Obtain a small sample of the unknown liquid.
3. Dip a piece of pH paper into the liquid.
4. Compare the colour of the wet pH paper with the standard scale of pH colours to determine if the unknown liquid is acidic, basic, or neutral.

**75.** The decrease in mass can be explained by errors in weighing, or perhaps there were drops of liquid on the beakers that evaporated during the experiment.

## Revisit the Big Ideas and Fundamental Concepts

**76.** Students' mind maps will vary. However, the maps should show how different concepts are connected. For example, they might show that neutralization reactions are connected to double displacement reactions.

## Science, Technology, Society, and the Environment

**77.** The products of a combustion reaction are carbon dioxide gas and water. Excess carbon dioxide causes global warming. We can reduce global warming by performing fewer combustion reactions. For example, if we drove our cars less, we would burn less fuel and so create less carbon dioxide. By consuming fewer products, we would reduce the amount of fuel burned to make and transport those products, which would reduce the amount of carbon dioxide released into the atmosphere. If the electricity we use comes from generating stations that burn fossil fuels, we could reduce the amount of electricity we use by turning out lights or using energy-efficient light bulbs. This would reduce the amount of carbon dioxide emitted from the plant. If we produce less waste, it would reduce the amount of fossil fuels used to transport and incinerate garbage.

**78.** Acid rain is less of a problem in Ontario in the 21st century than in the century before because we use scrubbers (a technology) to remove sulphur and nitrogen compounds from waste gases produced by some industries. Also, catalytic converters on cars reduce the amount of emissions that cause acid rain. Another reason is that we have laws that require industries to reduce acid rain–causing emissions.

**79.** Students answers will vary. Examples are reducing automobile use, buying fewer items, using products less frequently, throwing away fewer personal items, and turning down the heat.