

Answers to Numerical Questions

page 18, Practice Problems

1. $1000\times$
2. $40\times$
3. $400\times$

page 146, Learning Checkpoint

1. proton (1+), neutron (0), electron (1-)
2. proton and neutron
3. proton

page 148, Learning Checkpoint

1. lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, neon
2. silicon, germanium, tin, lead, ununquadium
3. (a) helium
(b) magnesium
(c) bromine
(d) oxygen
4. (a) period 2
(b) carbon, nitrogen, oxygen, fluorine, neon
5. (a) Group 18 (noble gases)
(b) for example: colourless, unreactive, gases

page 149, Learning Checkpoint

1. (a) hydrogen, H
(b) sodium, Na
(c) chlorine, Cl
(d) copper, Cu
(e) uranium, U
2. Answers are approximate:
(a) 4.0
(b) 12.0
(c) 16.0
(d) 207.2
(e) 197.0
3. (a) 1+
(b) 2-
(c) 1-
(d) 2+, 3+

page 150, Learning Checkpoint

1. (a) 3, 1
(b) 7, 5
(c) 10, 8
(d) 14, 4
(e) 20, 2

2. valence electrons are in the same shell
3. for example: helium, 2; neon, 10; argon, 18

page 158, Learning Checkpoint

1. (a) Mg^{2+}
(b) Cl^-
(c) Fe^{2+}
(d) Fe^{3+}
(e) U^{6+}
2. (a) zinc
(b) nitride
(c) cobalt(II)
(d) cobalt(III)
(e) lead(IV)

page 159, Practice Problems

1. lithium bromide
2. calcium iodide
3. aluminum oxide
4. magnesium nitride

page 160, Practice Problems

1. iron(II) chloride
2. iron(III) chloride
3. copper(II) nitride
4. nickel(III) oxide

page 161, Practice Problems

1. aluminum sulphate
2. calcium phosphate
3. iron(II) hydroxide
4. ammonium sulphide

page 163, Practice Problems

1. KI
2. Mg_3P_2
3. Ag_2S
4. FeBr_3

page 164, Practice Problems

1. $\text{Mg}(\text{OH})_2$
2. Na_2SO_4
3. $\text{Pb}(\text{NO}_3)_2$
4. $(\text{NH}_4)_2\text{CO}_3$

page 168, Practice Problems

1. sulphur trioxide
2. tetraphosphorus decasulphide
3. nitrogen trifluoride
4. dinitrogen monoxide

page 168, Practice Problems

1. SBr_6
2. CCl_4
3. N_2O_4
4. P_4O_{10}

page 171, 4.2 Check and Reflect

6. (a) aluminum
(b) calcium
(c) bromide
(d) sulphide
(e) sulphate
(f) phosphate
7. (a) BeO
(b) RbBr
(c) $\text{Ba}(\text{OH})_2$
(d) NH_4I
(e) $\text{Mg}_3(\text{PO}_4)_2$
(f) Fe_2O_3
(g) Cu_2SO_4
(h) CrPO_4
8. (a) zinc chloride
(b) calcium sulphide
(c) potassium sulphate
(d) ammonium nitrate
(e) strontium phosphate
(f) gold(III) chloride
(g) nickel(III) sulphide
(h) lead(IV) fluoride
12. (a) sulphur dioxide
(b) sulphur trioxide
(c) phosphorus triiodide
(d) oxygen difluoride
(e) sulphur hexaiodide
(f) diphosphorus tetrasulphide
13. (a) SBr_6
(b) NBr_3
(c) SCl_6
(d) P_2O_5
(e) CO

page 177, Learning Checkpoint

3. 3.5 g
5. 4 K, 2 O on both sides

page 178, Practice Problems

1. $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$
2. $6\text{HCl} + 2\text{Al} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2$
3. $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$

page 179, Practice Problems

- $2\text{HgO}(s) \rightarrow 2\text{Hg}(l) + \text{O}_2(g)$
- $2\text{Al}(s) + 3\text{Br}_2(l) \rightarrow 2\text{AlBr}_3(s)$
- $\text{Ca}(s) + 2\text{H}_2\text{O}(l) \rightarrow \text{Ca}(\text{OH})_2(s) + \text{H}_2(g)$

page 180, Practice Problems

- $3\text{H}_2(g) + \text{N}_2(g) \rightarrow 2\text{NH}_3(g)$
- $2\text{NO}(g) + \text{O}_2(g) \rightarrow 2\text{NO}_2(g)$
- $\text{Al}(s) + 3\text{HNO}_3(\text{aq}) \rightarrow \text{Al}(\text{NO}_3)_3 + \text{H}_2(g)$
- $\text{PCl}_3(g) + \text{Cl}_2 \rightarrow \text{PCl}_5(g)$

page 181, Practice Problems

- $2\text{Fe} + 3\text{Cl}_2 \rightarrow 2\text{FeCl}_3$
- $2\text{Na} + \text{Ca}(\text{OH})_2 \rightarrow 2\text{NaOH} + \text{Ca}$
- $2\text{Na}_3\text{PO}_4 + 3\text{Mg}(\text{OH})_2 \rightarrow \text{Mg}_3(\text{PO}_4)_2 + 6\text{NaOH}$
- $3\text{H}_2\text{SO}_4 + 2\text{Ni}(\text{OH})_3 \rightarrow \text{Ni}_2(\text{SO}_4)_3 + 6\text{H}_2\text{O}$

page 182, Practice Problems

- silver nitrate + copper \rightarrow copper(II) nitrate + silver
 $2\text{AgNO}_3(\text{aq}) + \text{Cu}(s) \rightarrow \text{Cu}(\text{NO}_3)_2(\text{aq}) + \text{Ag}(s)$
- magnesium chloride + potassium phosphate \rightarrow potassium chloride + magnesium phosphate
 $\text{MgCl}_2(\text{aq}) + \text{K}_3\text{PO}_4(\text{aq}) \rightarrow \text{KCl}(\text{aq}) + \text{Mg}_3(\text{PO}_4)_2(s)$
- hydrogen + carbon dioxide \rightarrow carbon monoxide + water
 $\text{H}_2(g) + \text{CO}_2(g) \rightarrow \text{CO}(g) + \text{H}_2\text{O}(l)$
- potassium + oxygen \rightarrow potassium oxide
 $4\text{K}(s) + \text{O}_2(s) \rightarrow 2\text{K}_2\text{O}(s)$

page 187, 4.3 Check and Reflect

- (a) aluminum + fluorine \rightarrow aluminum fluoride
 $2\text{Al}(s) + 3\text{F}_2(g) \rightarrow 2\text{AlF}_3(g)$
 (b) potassium + oxygen \rightarrow potassium oxide
 $4\text{K}(s) + \text{O}_2(g) \rightarrow 2\text{K}_2\text{O}(s)$

- (c) lithium sulphate + barium chloride \rightarrow barium sulphate + lithium chloride
 $\text{Li}_2\text{SO}_4(\text{aq}) + \text{BaCl}_2(\text{aq}) \rightarrow \text{BaSO}_4(s) + 2\text{LiCl}(\text{aq})$
 (d) aluminum chloride + sodium carbonate \rightarrow aluminum carbonate + sodium chloride
 $2\text{AlCl}_3(\text{aq}) + 3\text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{Al}_2(\text{CO}_3)_3(s) + 6\text{NaCl}(\text{aq})$

- (a) $\text{Al}(s) + 3\text{F}_2(g) \rightarrow 2\text{AlF}_3(s)$
 (b) $4\text{K}(s) + \text{O}_2(g) \rightarrow 2\text{K}_2\text{O}(s)$
 (c) $\text{C}_6\text{H}_{12}\text{O}_6(s) + 6\text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 6\text{H}_2\text{O}(l)$
 (d) $\text{H}_2\text{SO}_4(\text{aq}) + 6\text{NaOH}(s) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 6\text{H}_2\text{O}(l)$
 (e) $\text{Mg}(\text{CH}_3\text{COO})_2(\text{aq}) + 2\text{AgNO}_3(\text{aq}) \rightarrow \text{Mg}(\text{NO}_3)_2(\text{aq}) + 2\text{AgCH}_3\text{COO}(s)$
 (f) $2\text{H}_2\text{O}_2(\text{aq}) \rightarrow \text{O}_2(g) + 2\text{H}_2\text{O}(l)$
 (g) $2\text{HCl}(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \text{BaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(l)$
- (a) calcium + oxygen \rightarrow calcium oxide
 $2\text{Ca}(s) + \text{O}_2(g) \rightarrow 2\text{CaO}(s)$
 (b) propane + oxygen \rightarrow carbon dioxide + water
 $\text{C}_3\text{H}_8(g) + 5\text{O}_2(g) \rightarrow 3\text{CO}_2(g) + 4\text{H}_2\text{O}(g)$
 (c) fluorine + potassium chloride \rightarrow potassium fluoride + chlorine
 $\text{F}_2(g) + 2\text{KCl}(\text{aq}) \rightarrow 2\text{KF}(\text{aq}) + \text{Cl}_2(g)$

page 190, Chapter 4 Review

- (a) sodium
 (b) calcium
 (c) iron(III)
 (d) fluoride
 (e) oxide
- 45 atoms
- (a) O^{2-}
 (b) Br^-
 (c) S^{2-}
 (d) Ca^{2+}
 (e) Cu^+

- (a) NH_4^+
 (b) CO_3^{2-}
 (c) HCO_3^-
 (d) PO_4^{3-}
- (a) sodium nitride
 (b) calcium fluoride
 (c) aluminum hydroxide
 (d) iron(II) chloride
 (e) lead(IV) oxide
 (f) potassium permanganate
 (g) ammonium phosphate
 (h) chromium(II) nitrate
- (a) KI
 (b) Sr_3N_2
 (c) MnCl_4
 (d) SnS
 (e) $\text{Mg}(\text{OH})_2$
 (f) $\text{Zn}_3(\text{PO}_4)_2$
 (g) Ag_2O
 (h) NH_4NO_3
- (a) OnO
 (b) OnCl₂
 (c) On₃(PO₄)₂
- (a) N₂O₃
 (b) CO
 (c) SF₆
 (d) phosphorus pentabromide
 (e) carbon tetrachloride
 (f) nitrogen tribromide
- (a) $2\text{Li}(s) + \text{F}_2(g) \rightarrow 2\text{LiF}(s)$
 (b) $2\text{Be}(s) + \text{O}_2(g) \rightarrow 2\text{BeO}(s)$
 (c) $\text{HCl}(\text{aq}) + \text{NaOH}(s) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(l)$
 (d) $\text{Ca}(\text{CH}_3\text{COO})_2(\text{aq}) + 2\text{AgNO}_3(\text{aq}) \rightarrow \text{Ca}(\text{NO}_3)_2(\text{aq}) + 2\text{AgCH}_3\text{COO}(s)$
 (e) $2\text{NBr}_3(l) \rightarrow 3\text{N}_2(g) + 3\text{Br}_2(g)$
 (f) $2\text{HF}(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \text{BaF}_2(\text{aq}) + 2\text{H}_2\text{O}(l)$

page 197, Learning Checkpoint

- basic
- acidic
- 7.0

page 200, Learning Checkpoint

- (a) hydrochloric acid
 (b) nitric acid
 (c) acetic acid (or ethanoic acid)

2. (a) phosphate
(b) nitrate

page 201, Learning Checkpoint

1. (a) potassium hydroxide
(b) calcium hydroxide
(c) magnesium hydroxide
(d) ammonium hydroxide
2. OH⁻, hydroxide

page 203, 5.1 Check and Reflect

3. (a) basic
(b) acidic
(c) acidic
(d) acidic
(e) basic
7. (a) basic
(b) salt
(c) acidic
(d) acidic
8. (a) HNO₃(aq)
(b) CsOH
(c) HCl(aq)
(d) H₃PO₄
(e) potassium hydroxide
(f) sulphuric acid
9. (a) magnesium hydroxide
(b) potassium hydroxide
(c) aluminum hydroxide
10. (a) Mg(OH)₂
(b) KOH
(c) Al(OH)₃

page 206, 5.1 Practice Problems

1. $\text{HBr(aq)} + \text{KOH(aq)} \rightarrow \text{KBr} + \text{H}_2\text{O}$
2. $\text{H}_2\text{SO}_4(\text{aq}) + \text{Mg(OH)}_2(\text{aq}) \rightarrow \text{MgSO}_4(\text{aq}) + \text{H}_2\text{O}(l)$
3. $\text{H}_3\text{PO}_4(\text{aq}) + 3\text{NaOH(aq)} \rightarrow \text{Na}_3\text{PO}_4(\text{aq}) + 3\text{H}_2\text{O}(l)$

page 216, 5.2 Check and Reflect

8. (a) water
(b) sodium bromide
(c) hydrogen chloride (or hydrochloric acid)
9. (a) $\text{H}_2\text{SO}_4 + \text{Ca(OH)}_2 \rightarrow \text{H}_2\text{O} + \text{CaSO}_4$
(b) $\text{HBr} + \text{NaOH} \rightarrow \text{H}_2\text{O} + \text{NaBr}$
(c) $\text{HCl} + \text{NaOH} \rightarrow \text{H}_2\text{O} + \text{NaCl}$

10. (a) $\text{H}_2\text{SO}_4 + \text{Ca(OH)}_2 \rightarrow 2\text{H}_2\text{O} + \text{CaSO}_4$
(b) already balanced
(c) already balanced

page 218, Chapter 5 Review

4. (a) acidic
(b) neutral
(c) neutral
(d) basic
(e) basic
9. (a) acid
(b) acid
(c) base
10. (a) H₂SO₄; acid
(b) Ca(OH)₂; base
(c) HBr; acid
(d) Mg(OH)₂(aq); base
11. (a) hydrofluoric acid; acid
(b) nitric acid; acid
(c) sodium hydroxide; base
(d) ammonium hydroxide; base
(e) acetic acid (ethanoic acid); acid
(f) phosphoric acid; acid
(g) calcium hydroxide; base

page 226, Practice Problems

1. synthesis; $2\text{Li} + \text{Cl}_2 \rightarrow 2\text{LiCl}$
2. synthesis; $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$
3. synthesis; $\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$

page 227, Practice Problems

1. decomposition; $8\text{MgS} \rightarrow 8\text{Mg} + \text{S}_8$
2. decomposition; $\text{NaI} \rightarrow \text{Na} + \text{I}_2$
3. decomposition; $2\text{NaCl}(l) \rightarrow 2\text{Na(s)} + \text{Cl}_2(\text{g})$

page 229, 6.1 Check and Reflect

1. synthesis and decomposition
4. (a) decomposition
(b) decomposition
(c) synthesis
(d) synthesis
(e) decomposition
(f) decomposition
5. (a) synthesis
(b) iron(II)

6. (a) potassium chlorate → potassium chloride + oxygen
(b) $\text{KClO}_3(\text{s}) \rightarrow \text{KCl(s)} + \text{O}_2(\text{g})$
(c) $2\text{KClO}_3(\text{s}) \rightarrow 2\text{KCl(s)} + \text{O}_2(\text{g})$
7. $2\text{H}_2\text{O}(l) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$
8. zinc nitride → zinc + nitrogen
 $\text{Zn}_3\text{N}_2(\text{s}) \rightarrow 3\text{Zn(s)} + \text{N}_2(\text{g})$
9. magnesium + chlorine → magnesium chloride
 $\text{Mg(s)} + \text{Cl}_2(\text{g}) \rightarrow \text{MgCl}_2(\text{s})$
(already balanced)

page 233, Practice Problems

1. single displacement; $\text{Mg} + \text{Zn(NO}_3)_2 \rightarrow \text{Zn} + \text{Mg(NO}_3)_2$
2. single displacement; $\text{Fe(s)} + \text{AgNO}_3(\text{aq}) \rightarrow \text{Fe(NO}_3)_2(\text{aq}) + \text{Ag(s)}$

page 234, Practice Problems

1. single displacement; $3\text{F}_2 + 2\text{AlBr}_3 \rightarrow 3\text{Br}_2 + 2\text{AlF}_3$
2. single displacement; Cl_2 and $2\text{AgBr} \rightarrow \text{Br}_2 + 2\text{AgCl}$
3. single displacement; $3\text{Cl}_2(\text{g}) + 2\text{NiBr}_3(\text{aq}) \rightarrow 2\text{NiCl}_3(\text{aq}) + 3\text{Br}_2(l)$

page 235, Practice Problems

1. double displacement; $\text{AlCl}_3(\text{aq}) + 3\text{NaOH(aq)} \rightarrow \text{Al(OH)}_3(\text{s}) + 3\text{NaCl(aq)}$
2. double displacement; $\text{CuNO}_3(\text{aq}) + \text{KBr(aq)} \rightarrow \text{CuBr(s)} + \text{KNO}_3(\text{aq})$

page 240, 6.2 Check and Reflect

4. (a) double displacement
(b) neutralization
(c) combustion
(d) single displacement
(e) decomposition
(f) synthesis
7. (a) single displacement
(b) double displacement
(c) combustion
(d) double displacement

page 242, Chapter 6 Review

1. synthesis
7. neutralization, combustion
8. (a) double displacement
(b) neutralization
10. (a) potassium iodide
(b) cesium chloride
12. carbon dioxide, water
14. (a) synthesis
(b) decomposition
(c) single displacement
(d) double displacement
(e) combustion
(f) double displacement
(g) decomposition
15. double displacement; $\text{FeCl}_2(\text{aq}) + \text{K}_2\text{S}(\text{aq}) \rightarrow \text{FeS}(\text{s}) + 2\text{KCl}(\text{aq})$
16. $\text{FeS}(\text{s})$
17. (a) decomposition; $\text{CaCl}_2(\text{s}) \rightarrow \text{Ca}(\text{s}) + \text{Cl}_2(\text{g})$
(b) decomposition; $2\text{NaN}_3(\text{s}) \rightarrow 2\text{Na}(\text{s}) + 3\text{N}_2(\text{g})$
(c) double displacement;
 $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{Cu}_2\text{SO}_4(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + 2\text{CuNO}_3(\text{aq})$
(d) decomposition; $2\text{Ni}_2\text{O}_3(\text{s}) \rightarrow 4\text{Ni}(\text{s}) + 3\text{O}_2(\text{g})$
(e) combustion; $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
(f) double displacement
 $3\text{NaI}(\text{aq}) + \text{AlCl}_3(\text{aq}) \rightarrow 3\text{NaCl}(\text{aq}) + \text{AlI}_3(\text{s})$
18. (a) double displacement;
 $\text{Na}_2\text{SO}_4 + \text{CaCl}_2 \rightarrow 2\text{NaCl} + \text{CaSO}_4$
(b) synthesis; $3\text{Mg} + \text{N}_2 \rightarrow \text{Mg}_3\text{N}_2$
(c) double displacement;
 $\text{Sr}(\text{OH})_2 + \text{PbBr}_2 \rightarrow \text{SrBr}_2 + \text{Pb}(\text{OH})_2$
(d) synthesis; $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$
(e) synthesis; $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$
(f) decomposition; $2\text{HCl} \rightarrow \text{H}_2 + \text{Cl}_2$
(g) single displacement; $2\text{AlI}_3 + 3\text{Br}_2 \rightarrow 2\text{AlBr}_3 + 3\text{I}_2$

(h) neutralization; $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

19. synthesis; $\text{Ca} + \text{I}_2 \rightarrow \text{CaI}_2$
20. single displacement; $\text{Zn}(\text{s}) + \text{CuSO}_4(\text{aq}) \rightarrow \text{Cu}(\text{s}) + \text{ZnSO}_4(\text{aq})$
21. $\text{Mg}(\text{s}) + \text{Br}_2(\text{l}) \rightarrow \text{MgBr}_2(\text{s})$
22. zinc bromide + silver nitrate \rightarrow silver bromide + zinc nitrate
 $\text{ZnBr}_2(\text{aq}) + 2\text{AgNO}_3(\text{aq}) \rightarrow 2\text{AgBr}(\text{s}) + \text{Zn}(\text{NO}_3)_2(\text{aq})$

page 248, Unit B Review

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) positive
(b) negative
8. two
9. metals and non-metals
10. non-metals and other non-metals
15. 0 to 14
16. > 7
17. < 7
19. neutralization
22. 7
25. decomposition
26. (a) synthesis
(b) combustion
27. (a) $2\text{Na} + \text{Br}_2 \rightarrow 2\text{NaBr}$
(b) $\text{Mg} + \text{F}_2 \rightarrow \text{MgF}_2$
(c) $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$
(d) $6\text{K} + \text{N}_2 \rightarrow 2\text{K}_3\text{N}$
(e) $6\text{Ca} + \text{P}_4 \rightarrow 2\text{Ca}_3\text{P}_2$
28. single displacement
29. combustion
32. (a) 4
(b) 2
34. ammonium, NH_4^+
40. (a) sulphur
(b) hydrogen, chlorine
(c) nitrogen
(d) phosphorus
43. (a) single displacement
(b) combustion
(c) single displacement
(d) combustion
(e) double displacement
44. (a) $\text{Cu}(\text{NO}_3)_2(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Fe}(\text{NO}_3)_2(\text{aq}) + \text{Cu}(\text{s})$
(b) $2\text{C}_5\text{H}_{10}(\text{l}) + 15\text{O}_2(\text{g}) \rightarrow 10\text{CO}_2(\text{g}) + 10\text{H}_2\text{O}(\text{l})$
(c) $\text{Li}_4\text{C}(\text{s}) + 2\text{Ca}(\text{s}) \rightarrow 4\text{Li}(\text{s}) + \text{Ca}_2\text{C}(\text{s})$
(d) $2\text{C}_6\text{H}_{14}(\text{g}) + 19\text{O}_2(\text{g}) \rightarrow 12\text{CO}_2(\text{g}) + 14\text{H}_2\text{O}(\text{l})$
(e) $3\text{CsF}(\text{aq}) + \text{AlBr}_3(\text{aq}) \rightarrow 3\text{CsBr}(\text{aq}) + \text{AlF}_3(\text{s})$
45. calcium + bromine \rightarrow calcium bromide
 $\text{Ca} + \text{Br}_2 \rightarrow \text{CaBr}_2$
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 hydroxide
(j) ammonium hydrogen carbonate
50. (a) NaBr
(b) Be_3P_2
(c) Cu_2O
(d) $\text{Pd}(\text{NO}_3)_4$
(e) $(\text{NH}_4)_2\text{SO}_4$
(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
(b) synthesis
(c) single displacement
(d) decomposition
(e) double displacement
(f) neutralization

54. KCl

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

58. synthesis; $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$

59. (a) $\text{CS}_2 + 3\text{O}_2 \rightarrow \text{CO}_2 + 2\text{SO}_2$
 (b) $\text{Pb}(\text{NO}_3)_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2\text{NaNO}_3$
 (c) $\text{KBr} + \text{AgNO}_3 \rightarrow \text{AgBr} + \text{KNO}_3$

60. b, c

61. sulphuric acid + ammonium hydroxide \rightarrow ammonium sulphate + water
 $\text{H}_2\text{SO}_4 + 2\text{NH}_4\text{OH} \rightarrow (\text{NH}_4)_2\text{SO}_4 + 2\text{H}_2\text{O}$
62. benzene + oxygen \rightarrow carbon dioxide + water
 $2\text{C}_6\text{H}_6 + 15\text{O}_2 \rightarrow 12\text{CO}_2 + 6\text{H}_2\text{O}$

page 395, Learning Checkpoint

2. 5%

page 401, 10.2 Check and Reflect

6. (a) 5%
 (b) 20%

page 424, Practice Problems

1. $M = 250$
 2. $M = 4.6$
 3. $M = 4.68 \times 10^{-4}$

page 424, Practice Problems

1. $M = 0.667$
 2. $M = 1$
 3. $M = 7.5 \times 10^{-4}$

page 425, Practice Problems

1. $h_i = 140 \text{ cm}$ or 1.40 m
 2. $h_o = 0.80 \text{ cm}$ or 8.0 mm
 3. $h_i = 12 \text{ mm}$ or 1.2 cm

page 425, Practice Problems

1. $d_o = 0.5 \text{ cm}$
 2. $d_i = 322 \text{ cm}$ or 3.22 m
 3. $d_i = 120 \text{ mm}$ or 1.2 m

page 433, 11.1 Check and Reflect

11. 2.2×10^2 or about 220 times
 12. 8.0 cm

page 438, Practice Problems

1. $n = 1.81$
 2. $n = 1.43$
 3. $n = 2.42$, diamond

page 438, Practice Problems

1. $2.21 \times 10^8 \text{ m/s}$
 2. $8.57 \times 10^7 \text{ m/s}$
 3. $1.69 \times 10^8 \text{ m/s}$

page 441, Practice Problems

1. $\theta_2 = 22^\circ$
 2. $\theta_2 = 23^\circ$
 3. $\theta_2 = 35.5^\circ$

page 442, Practice Problems

1. 1.50
 2. 1.9
 3. 1.48

page 447, 11.2 Check and Reflect

11. 2.5
 12. 38°
 13. 1.47, Pyrex glass
 14. 1.13
 15. 1.33, water
 16. 17.0 m/s

page 455, Practice Problems

1. 3.5 mm
 2. 30 mm
 3. 2.86 mm

page 456, Practice Problems

1. larger, real, inverted, 60 cm
 2. 0.06 cm
 3. very far away

page 457, Practice Problems

1. 64 mm
 2. 2.1 cm
 3. 14 cm

page 462, 11.3 Check and Reflect

6. (a) $d_i = 12.0 \text{ cm}$
 (b) $h_i = 3.6 \text{ cm}$
 7. (a) $d_i = 60 \text{ cm}$
 (b) $M = 5.0$
 8. $1.030 \times 10^5 \text{ mm}$ or about 103 m

page 464, Chapter 11 Review

12. (a) 14.6 mm or 1.46 cm
 14. (a) 812 mm or 8.12 m
 (b) 11 mm or 1.1 cm
 15. 10°
 16. 8.4°
 17. 200 times
 18. (a) 8.0 cm
 (b) 1.5
 19. 0.43 mm
 20. 1.20
 21. 0.0°
 25. 8.0 mm

page 477, Learning Checkpoint

1. (a) less than 20°
 (b) 180°

page 504, Unit D Review

29. 300 million m/s or $3.0 \times 10^8 \text{ m/s}$
 67. 3.4×10^2 or about 340 times
 68. 0.241
 69. 1.8×10^7
 70. $1.97 \times 10^8 \text{ m/s}$
 71. 27.1°
 72. $1.1 \times 10^{-4} \text{ m}$
 73. 8.74 cm
 74. 4.5 cm
 75. 1.25 m

Notes: The numbers in parentheses at the end of each definition indicates the page number in this book where the term is defined. A pronunciation guide, using the key below, appears in square brackets after selected words.

a = tack, cat
 ae = day, clay
 ah = car, farther
 aw = dawn, hot
 e = bed, less
 ee = leaf, clean
 ih = idea, life

i = simple, this
 oh = home, loan
 oo = mood, root
 u = wonder, Sun
 uh = taken, traveller
 uhr = insert, turn

A

absorption process by which food that has already been broken down passes through the walls of the intestine into the bloodstream

acid substance that has a pH less than 7 when it is in aqueous solution (196)

acid leaching process in which acids dissolve metals found in soil; as the pH falls, heavy metals begin to dissolve (211)

acid precipitation rain, snow, fog, or dew that has a pH less than 5.6 (208)

acid-base indicator substance that changes colour in the presence of an acid or a base (197)

additive colour theory theory of light stating that white light is composed of different colours (wavelengths) of light (387)

albedo [al-BEE-doh] percent of incoming solar radiation reflected by a surface (278)

alkali metal member of the family of elements composed of soft, silver-grey metals that react easily with water and with oxygen in the air; group 1 on the periodic table (148)

alkaline earth metal member of the family of elements composed of silver-grey metals that are harder and more reactive than alkali metals; group 2 on the periodic table (148)

amplitude wave height from the rest position to the crest, or wave depth from the rest position to the trough; the larger the amplitude, the more energy that is carried (382)

anaphase [a-nuh-FAEZ] third phase of mitosis; phase in which the sister chromatids separate into individual chromosomes and move to opposite poles (32)

angle of incidence (*i*) angle between the incident ray and the normal (418)

angle of reflection (*r*) angle between the reflected ray and the normal (418)

anthropogenic greenhouse effect enhancement of the natural greenhouse effect due to increased greenhouse gas emissions caused by human activities (300)

aperture in a camera, opening that the light passes through (484)

apoptosis [AE-pawp-TOH-sis] controlled death of a cell that is no longer useful (33)

astigmatism condition in which the eye is unable to form a clear image because of an irregularly shaped cornea or lens (474)

atmosphere layer of gases that extends outward about 300 km from the surface of Earth (265)

atom smallest particle in matter (144)

atomic mass measure of the average mass of an atom of an element (149)

atomic number number of protons in an atom of an element (149)

atomic theory study of the nature of atoms and how atoms combine to form all types of matter (144)

axis of symmetry imaginary vertical line drawn through the optical centre of a lens (450)

B

base substance that has a pH greater than 7 when it is in aqueous solution (197)

binoculars two short refracting telescopes attached together (489)

bioluminescence [bi-oh-loo-min-ES-uhns] ability of a plant or animal to produce light (392)

biome [BIH-ohm] large geographical region with a defined climate (range of temperature and precipitation) (268)

biosphere [BIH-uh-sfeer] relatively thin layer of Earth that has conditions suitable for supporting life; includes the lithosphere, hydrosphere, and atmosphere (264)

blind spot place where the optic nerve attaches to the retina (472)

Bohr diagram illustration of an atom that shows the arrangement and number of electrons in each shell (145)

boiling point (condensation point) temperature of boiling (or condensing) (142)

C

camera lightproof box with a lens at one end to form a real, inverted image on a light detector or on a light-sensitive plate or film (484)

cancer cell cell that divides uncontrollably; develops when a mutation occurs in the cell that affects how that cell divides (34)

capillary thin-walled blood vessel (57)

carbon footprint total amount of greenhouse gas emissions caused directly and indirectly by an individual, community, industry, or country (350)

carbon offset contribution of money to a carbon sink to compensate for an individual's or company's greenhouse gas emissions (353)

carbon sink process that takes carbon dioxide from the atmosphere and stores it (302)

carbon source process that releases carbon dioxide to the atmosphere (301)

carbon tax charge to an individual or company for creating greenhouse gas emissions either directly or by purchasing a fossil fuel (354)

cell basic unit of life for all living things (10)

cell cycle repeating cycle of events in the life of a cell in which it grows and prepares for division (28)

cell membrane protective barrier formed around every cell; made of a double layer of lipids (12)

cell specialization process in which cells develop in different ways to perform particular functions (40)

cell wall rigid frame around a plant cell that provides strength, protection, and support (14)

centriole pair of structures involved in cell division in animal cells (16)

chemical change transformation of one or more substances into new substances with new properties (174)

chemical equation words, or symbols and formulas, that describe the changes that occur during a chemical reaction (175)

chemical property property related to the ability of a substance to change into a new substance or substances (142)

chemical reaction process by which chemical change happens; all chemical reactions are also accompanied by changes in energy (174)

chemiluminescence [KEM-i-loo-min-ES-uhns] light produced from a chemical reaction without a rise in temperature (395)

chloroplast organelle that contains a green substance called chlorophyll; found only in plant cells and some algae (15)

chromosome long piece of coiled DNA and proteins; only visible during mitosis (28)

circulatory system organ system that includes the heart, blood, veins, arteries, and capillaries; transports blood around the body (70)

climate average weather conditions that occur in a region over a long period of time, usually a minimum of 30 years (262)

climate change significant long-term change in expected climate patterns (303)

cloning creation of a genetically identical organism that is an exact copy of a gene, cell, tissue, or organism (115)

colour blindness ability to see only shades of grey; very rare, occurring in about 1 in 40 000 people (477)

colour vision deficiency ability to distinguish some colours but not others (477)

combustion chemical reaction in which a compound or element rapidly combines with oxygen gas (232)

compound pure substance made from two or more elements that are combined together chemically (143)

compound microscope type of light microscope in which a pair of convex lenses causes a small object to appear magnified when viewed through the eyepiece (487)

concave lens lens that is thinner at the centre than at the edges; also called a diverging lens (451)

concave mirror reflecting surface that curves inward like a bowl; also called a converging mirror (421)

concentration amount of a substance that has been dissolved in solution (12)

conduction transfer of thermal energy through direct contact between the particles of a substance without moving the particles to a new location (279)

conductivity ability to conduct heat or electricity (142)

cone cells photoreceptor cells in the eye that detect colour (472)

confidence level degree of confidence in predictions about a particular event (340)

convection transfer of thermal energy through the movement of particles from one location to another (280)

converging lens lens that is thicker at the centre than at the edges; also called a convex lens (452)

converging mirror reflecting surface that curves inward like a bowl; also called a concave mirror (421)

convex lens lens that is thicker at the centre than at the edges; also called a converging lens (452)

convex mirror reflecting surface that curves outward; also called a diverging mirror (426)

Coriolis effect [kor-ee-OH-luhs] deflection of any object from a straight-line path by the rotation of Earth (281)

cornea transparent layer of tissue on the outer surface of the eye covering the iris and pupil; refracts light entering the eye (470)

covalent bond connection, usually between the atoms of non-metals, in which the two atoms share a pair of electrons (164)

crest highest point in a wave (382)

crystal formation forming of particles with a crystalline appearance (142)

cytokinesis [sih-toh-kin-EE-suhs] division of the cytoplasm during mitosis (32)

cytoplasm [SIH-toh-plaz-uhm] jelly-like substance that fills the cell and surrounds the organelles (12)

cytoskeleton internal network of fibres within a cell; made up of protein filaments (14)

D

decomposition reaction chemical reaction in which a compound is broken apart into two or more elements and/or simpler compounds (226)

diaphragm in a camera, an adjustable opening that controls the aperture (484)

diatomic molecule molecule made from two atoms (164)

differentiation process in which stem cells become specialized so that they can perform different functions (40)

diffuse reflection reflection in which parallel light rays are scattered in different directions when reflected from an irregular surface (406)

diffusion process for moving substances across a cell membrane (12)

digestive system organ system made up of the mouth, esophagus, stomach, small and large intestine, and rectum; transports and absorbs nutrients in the body (68)

dispersion refraction of white light into separate wavelengths, or colours (440)

diverging lens lens that is thinner at the centre than at the edges; also called a concave lens (451)

diverging mirror reflecting surface that curves outward; also called a convex mirror (426)

DNA screening test in which DNA is analyzed to see if an individual has a series of genes related to certain diseases, such as heart disease and types of cancer (108)

double-displacement reaction chemical reaction in which the positive or negative ions in two dissolved ionic compounds switch places (235)

ductility ability to be stretched without breaking (142)

E

economic system organized way in which a country or region sets up activities related to how goods and services are produced, distributed, and consumed (322)

electric discharge method for producing light in which an electric current passes through the air or another gas (396)

electroluminescence process of transforming electrical energy directly into light energy (397)

electromagnetic radiation energy that can travel through

empty space in the form of waves (385)

electromagnetic spectrum entire range of wavelengths or frequencies of electromagnetic radiation extending from the shortest gamma rays to the longest radio waves and including light (385)

electron subatomic particle that has a negative charge of $1-$ (144)

element substance that cannot be broken down into any simpler substance by chemical means (143)

emissions trading system by which a company that reduces its emissions by more than the government limit can trade the extra amount to another company that has exceeded its maximum; also called “cap and trade” (354)

esophagus tube that allows food to travel from the mouth to the stomach (58)

excretory system organ system that includes the kidneys, ureters, urinary bladder, urethra, and skin; filters waste products from the blood and maintains the proper levels of water and electrolytes in the body (71)

F

family vertical column of the periodic table; elements in the same family in the periodic table have similar physical and chemical properties; also called a group (146)

far-sighted able to see distant objects clearly but not near objects clearly (473)

fluorescent describes light emitted by some substances when they are exposed to electromagnetic radiation (394)

focal length distance from the vertex to the focal point of a curved mirror (420)

focal point point where light rays meet or appear to meet (420)

formula equation chemical equation that uses formulas of the reactants and products (175)

fossil fuels hydrocarbons formed underground over millions of years from the remains of once-living organisms; fossil fuels are coal, oil, and natural gas (232, 301)

frequency (f) rate of repetition of a wave; measured in hertz (Hz), which is cycles per second (382)

G

gamma rays extremely high-energy electromagnetic radiation that can penetrate human tissue (385)

gene each section of DNA that codes for a particular protein (108)

gene therapy therapy in which healthy genes are inserted into cells so that cells function normally (114)

general chemical equation (GCE) equation that uses letters of the alphabet (A, B, C, D) in place of symbols for elements (224)

geometric optics science of how light reflects and refracts (417)

global warming observed increases in Earth's average annual temperature (303)

global warming potential measure of the ability of a greenhouse gas to trap thermal energy in the atmosphere (298)

Golgi apparatus [GOHL-jee] structure that receives proteins from the endoplasmic reticulum; modifies, sorts, and packages these proteins for delivery throughout the cell or outside the cell (14)

granum [GRAE-nuhm] stack of thylakoids (15)

greenhouse gas gas that contributes to the natural greenhouse effect, such as water vapour, carbon dioxide, nitrous oxide, or methane; last three also contribute to the anthropogenic greenhouse effect (276)

group vertical column of the periodic table; elements in the same family in the periodic table have similar physical and chemical properties; also called a family (146)

H

halogen member of the family of elements composed of very reactive, coloured non-metals; group 17 on the periodic table (148)

heart muscular pump that supplies blood to all parts of the body (57)

heterogeneous mixture mixture in which different parts of the mixture are visible (143)

homeostasis tendency of an organism to maintain a steady state; an acceptable range of physical and chemical conditions in which body cells, tissues, and organs can operate efficiently (79)

homogeneous mixture mixture that looks the same throughout and the separate components are not visible; sugar water is a solution of sugar dissolved in water (143)

hydrocarbon compound made of only carbon and hydrogen (232)

hydrosphere includes all of the water on Earth, with about 97 percent of this water being salt water in the Earth's oceans (267)

I

image in optics, reproduction of an object seen in reflective surfaces such as calm water or glass (418)

immunization making a person resistant to infection through vaccination (105)

incandescent describes light produced by an object, such as a metal, that is at a very high temperature (394)

incident ray ray that strikes a reflecting or refracting surface (418)

index of refraction amount by which a transparent material decreases the speed of light; indicated by a number; also called refractive index (437)

infrared waves electromagnetic radiation that has wavelengths shorter than microwaves but longer than the visible spectrum (384)

insolation amount of solar energy received by a region of Earth's surface (276)

integumentary system [in-TEG-yoo-MEN-tuh-ree] organ system made up of skin and accessory structures (68)

interdependant connection between parts so that one part contributes to the action of another part; e.g., body systems are interdependent because the action of each system contributes to the actions of the other systems (80)

interphase stage in the cell cycle in which the cell grows and prepares for cell division (28)

intestine area of chemical digestion and removal of wastes (58)

ion atom or group of atoms with a negative charge or a positive charge (149)

ionic compound compound formed from one or more positively charged ion(s) and one or more negatively charged ion(s) (156)

iris circular coloured band of muscle in the eye that controls the size of the pupil and the amount of light that enters the eye (470)

K

Kyoto Protocol UNFCCC agreement among countries to reduce their greenhouse gas emissions (342)

L

laser light in which all the light rays are almost perfectly parallel, all have the same wavelength, and all wave crests and troughs are exactly lined up (490)

law of conservation of mass scientific law stating that the mass of the products always equals the mass of the reactants in a chemical reaction (176)

law of reflection scientific law stating that when light reflects off a surface, the angle of incidence always equals the angle of reflection; refers to the predictable behaviour of reflected light (418)

lens curved transparent object that is smooth and regularly shaped, so that when light strikes it, the light refracts in a predictable and useful way (450)

light-emitting diode (LED) electroluminescent light source made from a semiconductor (397)

liquid crystal solid that can change the orientation of its molecules like a liquid, but only when electricity is applied (398)

liquid crystal display (LCD) light source in which white light, such as a fluorescent light or light-emitting diode, shines behind a liquid crystal (398)

lithosphere solid portion of Earth that floats on the semi-fluid portion of the upper mantle (266)

lung one of a pair of organs involved in respiration (57)

lysosome small organelle filled with enzymes; where digestion takes place (13)

M

magnification measure of how much larger or smaller an image is compared with the object itself (423)

malleability ability to be beaten or rolled into sheets without crumbling (142)

matter anything that has mass and takes up space (has volume) (142)

mechanical mixture mixture that may contain several solids combined together (143)

medical imaging taking images of organs and tissues within the body for use in diagnosis and treatment (93)

medium material that is being used or is undergoing a process; plural is media (436)

melting point (freezing point) temperature of melting (or freezing) (142)

meristematic cells [mer-i-stuhm-AT-ik] stem cells that are found in plants and can become specialized (41)

meristematic tissue plant tissue formed from groups of meristematic cells (43)

mesophyll [ME-zuh-fil] specialized ground tissue in which photosynthesis and gas exchange occurs (44)

metal element that is ductile, malleable, shiny, usually silver, and generally a good conductor of heat and electricity; metals are found on the left and in the centre of the periodic table (146)

metalloid element with properties intermediate between the properties of metals and non-metals; on the periodic table, metalloids are arranged in a staircase that separates metals from non-metals (146)

metaphase second stage of mitosis; phase at which each chromosome lines up at the centre of the cell and the mitotic spindle forms (32)

microwaves electromagnetic radiation that has shorter wavelengths and higher frequency and carries more energy than radio waves (384)

mirage image of a distant object produced when light refracts through air of different densities (443)

mitigation making something milder or less severe (350)

mitochondria [mih-toh-KAWN-dree-uh] organelles that convert the chemical energy in sugar into energy that the cell can use; known as the power houses of the cell; singular is mitochondrion (13)

mitosis [mih-TOH-sis] stage of the cell cycle in which the cell divides into two new daughter cells (28)

mixture combination of pure substances; proportions of the pure substances in a mixture can vary, so the properties of the mixture vary as well (143)

model representation of an object, event, or process based on what we observe about the characteristics and properties (386)

molecular compound compound formed when atoms of non-metals combine (165)

molecular element element that exists as a molecule of two or more atoms joined by a covalent bond(s); e.g., O₂ (164)

molecule combination of two or more atoms held together by covalent bonds (164)

multivalent element element that can form an ion in more than one way (158)

N

natural greenhouse effect absorption of thermal energy by the atmosphere, maintaining Earth at an average temperature suitable for life (276)

near-sighted able to see near objects clearly but not distant objects clearly (474)

net radiation budget difference between the amount of incoming radiation and amount of outgoing radiation (277)

neutral describes a substance with a pH of 7 when in aqueous solution; a neutral substance, such as pure water, is neither an acid nor a base (196)

neutralization chemical reaction between an acid and a base that produces water and a salt (206)

neutron subatomic particle that is neutral; neutrons have a charge of 0 (144)

noble gas member of the family of non-metal gases that are colourless, odourless, and unreactive; group 18 on the periodic table (148)

non-metal element that is not a metal and usually is a poor conductor of heat and electricity; non-metals are located on the right-hand side of the periodic table (146)

normal in optics, an imaginary dashed line drawn perpendicular to a reflecting or refracting surface at the point of reflection or refraction (418)

nucleus (atomic) central core in an atom, composed of protons and neutrons (144)

nucleus (cell) control centre organelle of a cell (12)

O

opaque absorbing and reflecting light but not transmitting it (404)

ophthalmologist [off-thal-MAWL-uh-jist] physician who specializes in eye care (469)

optic nerve nerve that connects the eye to the brain (472)

optical device technology that uses light (418)

optical fibre solid strand of glass that can transmit light, even around corners (434)

optometrist trained professional in vision testing (469)

organ organized group of tissues that work together to perform a specific function (54)

organ system group of organs that work together to carry out specific duties in the body (65)

organelle small cell part that maintains life processes of the cell (10)

organic light-emitting display (OLED) light source in which several extremely thin layers of organic molecules use an electric current to create light (397)

P

penumbra area of partial shadow from a non-point light source (405)

period horizontal row of the periodic table (146)

persistence length of time a greenhouse gas remains in the atmosphere (298)

pH scale number scale that indicates how acidic or basic a solution is (196)

phloem [FLOH-em] vascular tissue in a plant that transports the sugar produced during photosynthesis from the leaves to the other parts of the plant (45)

phosphor [FAWS-fohr] substance that glows after being exposed to energized particles (394)

phosphorescence ability to store the energy from a source of light and then emit it slowly over a long period (395)

photon tiny packet of light energy, according to one model of how light travels; in this model, the colour of light is related to the amount of energy carried by each photon (491)

photonics technologies that make use of the way in which light travels as photons (491)

photoreceptors cells in the retina that are sensitive to light, called rod cells and cone cells (472)

physical property property related to the physical appearance and composition of a substance (142)

pixels tiny picture elements in an image assigned a single colour and brightness (485)

plane mirror mirror that has a flat reflective surface (419)

plasma display light source including tiny fluorescent lights in which an electrical signal causes a gas, such as neon, to release ultraviolet radiation (398)

polyatomic ion group of atoms, usually of different elements, that act as a single ion (160)

positive feedback loop sequence of events that cycles back to one of the earlier events in the sequence and enhances the outcome (326)

precipitate suspension of small, solid particles formed during a chemical reaction (206)

prism transparent glass or plastic object with flat polished sides that separates light into its component colours (386)

product new substance formed during a chemical reaction (174)

property attribute common to all substances or objects of the same group (386)

prophase first phase of mitosis, when the chromatin condenses to form chromosomes, and the centrioles separate and move to opposite sides of the nucleus (31)

proton subatomic particle that has a positive charge of 1+ (144)

public health strategies programs for health promotion and disease prevention; e.g., immunization programs, programs to promote healthy lifestyles, health education programs, and screening services (104)

pupil transparent area in the centre of the eye that allows light to pass into the eye (470)

pure substance substance composed of only one kind of matter and having a unique set of properties, such as colour, hardness, melting point, and conductivity; may be either an element or a compound (143)

R

radiation emission of energy as waves (279)

radio waves electromagnetic radiation that has the longest wavelength and lowest frequency (384)

ray model of light model representing light as straight lines, called rays, that show the direction in which light travels (404)

reactant starting substance in a chemical reaction (174)

real image image formed by rays that come from the location of the image (420)

red blood cell blood cell that contains hemoglobin, a protein that can absorb and release oxygen (42)

reflect to bounce off an object, such as when a light wave strikes an object (388)

reflecting telescope telescope in which light enters from one end of a tube and then reflects off a concave mirror toward a small plane mirror (489)

refracting telescope telescope that has two convex lenses, one on each end of a long tube (488)

refraction bending of light rays as they pass from one medium into another (436)

regeneration process in which a body part is replaced or regrown (38)

regular reflection reflection in which parallel light rays strike a smooth surface and stay parallel (406)

respiratory system system made up of various organs including the nose, mouth, trachea, lungs, bronchi, bronchioles, and diaphragm; function is to obtain oxygen and release carbon dioxide (69)

rest position in water, the level of the water when there are no waves (382)

retina inner lining at the back of the eye that acts as a projection screen for light rays entering the eye (471)

ribosome [RIH-buh-sohm] small dense-looking organelle that is attached to rough endoplasmic reticulum or free in the cytoplasm (14)

rod cells cells located in the retina that help to detect shapes and movement in low light situations (472)

rough endoplasmic reticulum organelle that is made of a series of interconnected small tubes and that carries materials through the cell; has ribosomes attached; associated with making proteins (14)

runaway positive feedback loop feedback loop in which the sequence of events appears to speed up with each cycle (327)

S

salinity [sa-LIN-i-tee] salt content of water (314)

sequester [suh-KWES-tuhr] to store permanently (350)

shell cloud-like energy level that surrounds the nucleus of an atom; occupied by one or more electrons (144)

shutter in a camera, device that controls the length of time light is allowed in to the lens (484)

single-displacement reaction chemical reaction in which an element reacts with an ionic compound; during the reaction, the element becomes part of the ionic compound, while one of the elements in the ionic compound becomes an element by itself (233)

sister chromatid [KROH-muh-tid] one of two identical copies of a chromosome (29)

skeleton equation chemical equation that is complete except for coefficients; also called an unbalanced equation (178)

skin largest organ in the body; made up of two layers of tissues, the epidermis and the dermis; protects the inner cells from damage, acts as a defence against disease organisms, insulates, releases heat, and excretes bodily wastes (56)

smooth endoplasmic reticulum organelle made of a series of interconnected small tubes that carry materials through the cell; associated with the production of fats and oils (14)

Snell's law formula that states the relationship between the angle of incidence and the angle of refraction: $n_1 \sin \theta_1 = n_2 \sin \theta_2$ (441)

solar oven cooking device that uses light from the Sun as its energy source; also called a solar cooker (423)

solar radiation radiant energy given off by the Sun (264)

solubility ability to dissolve in a liquid (142)

state phase of matter: solid, liquid, or gas (142)

stem cell unspecialized cell that can form specialized cells (40)

stomach organ made of epithelial, connective, nervous, and muscle tissues; churns food and mixes it with digestive juices and enzymes (58)

stomate [STOH-maet] tiny opening, or pore, in the underside of a leaf that allows carbon dioxide, water vapour, and oxygen to move into or out of the leaf easily; plural is stomata (44)

subtractive colour theory theory of light stating that coloured matter selectively absorbs different colours, or wavelengths, of light; colours that are absorbed are "subtracted" from the reflective light seen by the eye (388)

suspension cloudy mixture formed when tiny particles of one substance are held within another substance (143)

sustainable development use of the world's resources in ways that maintain these resources for future generations with minimal environmental impact (342)

synthesis reaction chemical reaction in which two elements combine to form a compound; the reactants may be a metal element and a non-metal element or two non-metal elements (225)

T

telephoto lens in a camera, lens that increases the amount of light that is collected and magnifies a distant object (485)

telescope optical device that provides enlarged images of distant objects (488)

telophase fourth and final phase of mitosis, when the cell divides the cytoplasm into two portions (32)

thermal energy total kinetic energy of the molecules or atoms in a substance (264)

thin lens lens whose thickness is slight compared to its focal length (452)

thin lens equation equation that states the relationship of the distance of an object from the lens (d_o), the distance of the image from the lens (d_i), and the focal length of the lens (f): $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ (454)

thylakoid [THIH-luh-koyd] one of the little sacs that make up a chloroplast; collects light energy from the Sun, which is used in photosynthesis (15)

tissue group of cells that function together to perform a specialized task (42)

total internal reflection type of reflection in which light reflects completely off the inside wall of a denser medium, rather than passing through the wall into a less dense medium (442)

transgenic organism [tranz-JEN-ik] organism that contains genes from other species (116)

translucent transmitting some, but not all, light rays (404)

transparent transmitting light rays freely, as in clear glass or clear plastic (404)

transpiration the evaporation of water through the stomata in leaves (72)

triboluminescence [TRIH-boh-loo-min-ES-ens] light produced from friction (396)

trough lowest point in a wave (382)

U

ultraviolet electromagnetic radiation that carries more energy than the visible spectrum but less energy than X-rays (385)

umbra part of a shadow in which all light rays from the light source are blocked (405)

universal indicator mixture of chemicals that changes colour through a wide range of pH values (197)

V

vacuole [VAK-yoo-ohl] membrane-bound organelle that stores nutrients, wastes, and other substances used by a cell; in plant cells, the central vacuole stores water for the cell (13)

valence electron electron in the valence shell of an atom (145)

valence shell outermost shell of an atom (145)

vertex middle point of a curved mirror (420)

vesicle membrane-bound organelle that transports substances throughout the cell (13)

virtual image image formed by rays that do not come from the location of the image (419)

visible spectrum range of wavelengths of light that can be detected by the human eye (386)

W

wave disturbance that transfers energy from one point to another without transferring matter (382)

wave model of light model of light comparing light to water waves; in this model, similarities between light and the movement of waves on the surface of water are used to explain several properties of visible light (386)

wavelength (λ) distance from one place in a wave to the next similar place on the wave, such as from crest to crest; measured in metres (382)

weather environmental conditions that occur in a particular place at a particular time (262)

wide-angle lens in a camera, lens that captures a wider angle of view than a regular lens or telephoto lens (485)

wind movement of air from areas of high pressure to areas of low pressure (281)

word equation chemical equation that uses the names of the reactants and products (175)

X

X-rays very high-energy electromagnetic radiation that can penetrate human tissue (385)

xylem [ZIH-lem] vascular tissue in a plant that carries water and minerals from the roots up the stem to the leaves (45)

A

Aamjiwnaang First Nation, 152
 Abiotic particles, 265
 Absorption, **68**
 Acetylene gas, 230–231
 Acid-base indicators, **197**
 Acidity, 196
 of oceans, 317
 of soil, 204–205, 207
 Acid leaching, **211**, 211–212
 Acid precipitation, **208**
 Acids, 194–195, **196**
 identifying, 196–197, 198–199
 naming, 199
 properties, 198
 transporting, 212
 Acquired Immunodeficiency Syndrome (AIDS). *See* HIV/AIDS
 Additive colour theory, **387**
 Aerosol pollution, 339
 Air, 265
 Air bags, 172–173
 Albedo, **278**, 288, 327
 Alkali metals, **148**
 Alkaline earth metals, **148**
 Alkalinity, 201
 Alkalis, 201
 Alveoli, 57, 69
 Ammonia, 194, 225
 Amniocentesis, 96
 Amplitude, **382**
 Anaphase, **32**
 Angiograms, 95
 Angle of incidence, **418**, 439, 442–443
 Angle of reflection, **418**
 Angle of refraction, 439, 442–443
 Animals
 bioluminescent, 392–393
 cells, 10
 climate change and, 315–317
 cloning of, 115–116
 forests and, 342
 organs, 56–58
 organ systems of, 66–71
 ranges of, 315–316
 threatened species, 316–317
 tissues, 42–43, 46
 transgenic, 116, 119
 Antacids, 207, 213
 Antarctica, 256, 257
 Anthropogenic greenhouse effect, **300**, 303, 306
 Anus, 58

Aperture, of camera, **484**
 Apoptosis, **33**
 Arctic Ocean, 256–257, 286, 327
 Arrhenius, Svante, 299
 Arteries, 70, 82
 Artificial insemination (AI), 117
 Astigmatism, **474**
 Atala, Anthony, 39
 Atmosphere, **265**, 265–266
 climate change and, 310–312
 thermal energy transfer in, 280–283
 Atmospheric pressure, 280–281
 Atomic mass, **149**
 Atomic number, **149**
 Atomic theory, **144**, 144–145
 Atoms
 and matter, 144–145
 in products, 176–177
 in reactants, 176–177
 Axis of symmetry, **450**

B

Bacteria
 pH and, 207
 Salmonella, 121
 as transgenic organisms, 116, 119
 vaccines and, 102
 Balanced, defined, **176**
 Bar graphs, 538–539
 Bases, 194–195, **197**
 identifying, 196–197, 200
 naming, 201
 Basur, Sheela, 48
 Batteries, 352
 ion, 154–155
 Bee stings, 207
 Binoculars, **489**
 Biofuels, 359
 Bioluminescence, **392**, 392–393, 395
 Biomes, 267–269, **268**, 272
 Biophotonics, 99
 Biosphere, **264**, 264–267
 Biotic particles, 265
 Blindness, 476
 Blind spot, **472**
 Blood pressure, 82
 Bohr diagrams, **145**, 150, 156
 Bombardier beetles, 241
 Boyle, Willard S., 410
 Brain, 55, 136–137
 Breathing, 57, 70, 76
 Bronchial tubes, 57
 Bronchioles, 69

C

Cambium, 41
 Cameras, **484**, 484–486
 cellphone, 410, 485
 digital, 491
 pill, 376–377
 and privacy, 495
 single-use, 493–494
 Cancer, 490
 screening, 108
 skin, 27, 107, 109
 Cancer cells, **34**, 36, 490
 Capillaries, **57**, 70, 71
 Carbon credits. *See* Carbon offsets
 Carbon dioxide
 in circulatory system, 71
 combustion reactions and, 232
 fossil fuels and, 301
 as greenhouse gas, 298, 299, 300
 and oceans, 317
 in photosynthesis, 59
 in respiratory system, 57, 69
 sequestering of, 353
 Carbon footprints, **350**, 353
 Carbon offsets, 343, **353**, 358
 Carbon sinks, **302**, 313
 Carbon source, **301**
 Carbon taxes, **354**
 Carmack, Eddy, 314
 Catalytic converters, 210
 Cell cycle, **28**, 28–32
 Cell membrane, **12**, 32
 Cells, **10**
 animal, 10
 biological diagrams of, 22
 cancer, 34, 36
 death of, 33–34
 differences between plant and animal, 16, 24
 discovery of, 8–9
 division of, 13, 28, 29, 32–33
 growth of, 32–33
 microscopes and, 8–9. 16–20
 modelling, 21
 mutations of, 34
 parts of, 10–16
 plant, 10, 14–15
 repair of, 32–33
 skin, 26–27
 stem, 40–41, 61
 Cell specialization, **40**, 40–45
 Cell wall, **14**
 Centrioles, **16**, 31

- Centromere, 31, 32
 Charge-coupled devices (CCDs), 410, 484, 488, 491
 Chemical bonds, 156
 Chemical changes, **174**, 186
 Chemical equations, **175**
 balanced, 178–179, 181–182
 skeleton, 178–180
 unbalanced, 178–180
 word, 175, 180
 Chemical industry, in Ontario, 140–141, 152
 Chemical properties, **142**, 142–143
 Chemical reactions, **174**, 174–175
 mass and, 184–185
 simulating, 223
 types of, 224–227, 232–237
 Chemiluminescence, **395**
 Chemistry
 and automobiles, 172–173
 backgrounder, 546–548
 in everyday life, 137, 183
 Chlorophyll, 15, 16
 Chloroplasts, **15**
 Chromatin, 13, 31
 Chromosomes, 13, **28**, 28–29
 Circle graphs, 539
 Circulatory system, 66, 67, **70**, 80, 82–83
 Climate, **262**, 262–263
 biomes and, 268–269
 and everyday life, 263
 plate tectonics and, 267
 and tree rings, 296–297
 Climate change, 257, 290, **303**, 303–305
 adapting to effects of, 354–357
 and atmosphere, 310–312
 confidence level of models, 340
 economic effects of, 320–330, 322–323
 food production and, 322, 323
 future of, 336–347
 human activities and, 305, 308–309
 in hydrosphere, 312–315
 personal responsibility regarding, 357
 physical effects of, 308–317, 326–327
 political action on, 341–342
 positive effects of, 327
 reducing impacts at school, 327
 and societies, 321, 323–325
 and wildlife, 315–317
 Climatographs, 270
 Cloaca, 69
 Cloning, **115**, 115–116
 Coal, 301
 Coefficients, **175**
 Colour blindness, **477**
 Colour(s)
 additive colour theory of light, 387
 component, of light, 389
 of laser light, 491
 light and, 380–381
 subtractive colour theory of light, 388, 389
 of visible spectrum, 386–387
 Colour vision deficiency, **477**
 Combustion, **232**
 Communicating, 526–529
 Compound microscopes, **487**
 Compounds, **143**, 156. *See also* Ionic compounds; Molecular compounds
 binary, 167
 solubility of, 155
 Computed tomography (CT), 97, 100
 Computer models, 338–340
 Computers, optical, 492
 Concave lenses, **451**, 451–452, 455–456
 Concave mirrors, **421**, 421–425, 429, 430–431, 488
 Concentration, **12**
 Conduction, **279**
 Cone cells, **472**
 Confidence levels, 337, **340**
 Confocal microscopes, **487**
 Connective tissue, 42, 56
 Convection, **280**, 313
 Converging lenses, **452**
 Converging mirrors, **421**
 Convex lenses, **452**, 452–454, 455–456, 460, 471, 484, 488
 Convex mirrors, **426**, 426–427, 429
 Cooke, Alistair, 113
 Coral reefs, 316–317
 Coriolis effect, **281**, 281–282, 285, 286
 Cornea, **470**, 471, 475
 Covalent bonds, 164, **164**, 165
 Crests, of waves, **382**, 383
 Critical angle, 443
 Currents
 convection, 280, 313
 ocean, 285, 314–315
 Cytokinesis, **32**
 Cytoplasm, **12**, 28
 Cytoskeleton, **14**
D
 Decomposition reactions, **226**, 226–227
 Dermis, 56
 Diagnostic testing, 92–100
 Diaphragm
 in breathing, 70
 of camera, **484**
 Diatomic molecules, **164**
 Differentiation, **40**
 Diffuse reflection, **406**
 Diffusion
 in circulatory system, 71
 in plant cells, **12**
 Digestion, 58, 65, 195
 Digestive system, 66, 67, **68**, 68–69, 74–75
 Digital images, 485–486
 Dispersion, **440**
 Dissection, 62, 73, 478–479
 Diverging lenses, **451**
 Diverging mirrors, **426**
 DNA (deoxyribonucleic acid), 13, 194
 antibiotics and, 33
 and cell mutations, 34
 and chromosomes, 28–29
 UV radiation and, 27, 107
 X-rays and, 95
 DNA screening, **108**, 108–109
 Double displacement reactions, **235**
 Droughts, 310, 311, 314, 354
 Drugs, 84
E
 Echocardiogram, 96
 Economic systems, **322**, 322–323
 greenhouse gases and, 356
 Kyoto Protocol and, 343–344
 Electric discharges, **396**
 Electricity
 reducing use of, 351–352
 renewable generation of, 352
 Electroluminescence, **397**
 Electromagnetic radiation, 384–385, **385**, 394, 437
 Electromagnetic spectrum, 384–385, **385**
 Electromagnetic waves, 279
 Electrons, **144**
 Elements, **143**
 molecular, 164–165
 multivalent, **158**
 periodic table of, 146–150
 Emissions, 302. *See also* Greenhouse gases
 increase in, 303
 mitigation of, 350–354
 per capita, 323–324
 reduction of, 210, 342–343, 351–354
 as waste, 348–349
 Emissions trading, **354**
 Endocrine system, 67
 Endoplasmic reticulum, 14
 Endoscopes, 376–377

- Energy
 in animal vs. plant cells, 16
 resource use among countries, 356–357
 Sun and, 264
 in waves, 382–383
- Environment
 combustion reactions and, 232
 and mitosis, 33
 neutralization reactions and, 208–212
- Environmental educators, 291
- Environmental toxins, 84
- Epidermal tissue, 44, 59, 60
- Epidermis, 56
- Epithelial tissue, 42, 57, 58
- Equator, 264, 276, 280, 281, 282–283, 285
- Esophagus, **58**
- Estimating, 537
- Ethics
 reproductive technologies and, 117–118
 stem cells and, 41, 61
- Everyday life
 chemistry in, 137, 183
 climate and, 263
 lifestyle choices and climate change,
 305, 308–309
 media and, 110
 outdoor activities, 106–107
 transportation decisions in, 359
- Excretory system, 67, **71**, 83–84
- Eyeglasses
 for night vision, 381, 384, 448–449
 self-adjusting, 463
- Eyes. *See also* Vision
 dissection of, 478–479
 examination of, 469
 as organs, 55
 parts of, 470
- F**
- Families, chemical, **146**, 148
- Far-sightedness, **473**
- Fertilizer plants, 237
- Fibre optics, 434–437, 443
- Floods, 312, 339
- Flowers, 60, 62
- Fluorescence, 136–137, **394**
- Fluoroscopy, 95
- Focal length, **420**, 450, 459, 471, 484
- Focal point, **420**, 421, 450
- Food, production of, 323, 342
- Forests and forestry, 208, 342
- Formula equations, 175, 176–177
 for compounds with polyatomic ions,
 163–164
 for ionic compounds, 162–163
- Fossil fuels, **232**, 300, **301**
 in production and distribution of goods,
 322
 reducing consumption of, 352–353
- Fox, Michael J., 61
- Frequencies, **382**
 of colours, 386
 wavelengths and, 383
- Functional magnetic resonance imaging
 (fMRI), 136
- Future
 of climate change, 336–347
 predicting, 336–337
- G**
- Galileo Galilei, 377, 482–483
- Gamma rays, **385**
- General chemical equations (GCE), **224**
- Genes, **108**
- Gene therapy, **114**
- Geometric optics, 416–417, **417**
- G8 (Group of Eight), 323, 344
- Gilbertson, Michael, 152
- Glare, 402
- Global warming, 232, **303**, 303–305
- Global warming potential, **298**
- Glucose, 165, 194
- Glycogen, 16
- Go Green, 344, 345
- Golgi apparatus, **14**
- Goods
 production and distribution of, 322
 transportation of, 322, 327
- Gore, Al, 304
- Grana, **15**
- Graphic organizers, 530–531
- Graphing, 538–541
- Greenhouse gases, **276**, 298–305
 emission of. *See* Emissions
- Greenhouses, 274–275, 287
- Greenland Ice Core Project (GRIP), 299–300
- Ground tissue, 44, 59, 60
- Groups, chemical, **146**
- H**
- Halogens, **148**
- Health education programs, 109
- Heart, 54, **57**, 70, 96
- Heating of buildings, 352–353
- Heat waves, 310
- Heavy metals, 211–212
- Hertz (Hz), 382
- Heterogeneous mixtures, **143**
- HIV/AIDS, 105, 109
- Homeostasis, **79**
- Home products
 hazard symbols, 511
 pH of, 202
- Homogeneous mixtures, **143**
- Hooke, Robert, 8
- Hormones, 83
- HPV (human papillomavirus), 105–106
- Human activities. *See also* Everyday life
 and climate change, 305, 308–309
- Human Immunodeficiency Virus (HIV). *See*
 HIV/AIDS
- Hydrocarbons, **232**, 301
- Hydrochloric acid, 195, 197, 207
- Hydrologic cycle, 284, 342
- Hydrosphere, **267**
 climate change in, 312–315
 thermal energy transfer in, 284–285
- I**
- Ice
 cores, 299–300
 melting of, 256–257, 312–313, 314, 327
 shelves, 256–257
 storms, 311
- Images, **418**
 convex lens, 460
 digital, 485–486, 492
 in mirrors, 417
 properties of, 461
 real, 453
 reversal of, 419
- Immunization, 102, **105**, 105–106
- Incandescence, **394**
- Incident ray, **418**
- Index of refraction, **437**, 437–438, 439,
 444–445
- Industrial Revolution, 300, 302
- Influenza, 4–5, 102–103
- Infrared radiation, 276, 277, 390
- Infrared waves, **384**
- Inquiry process, 512–515
- Insolation, **276**, 276–277
- Integumentary system, 66, 67, **68**, 80
- Interdependent, defined, **80**
- Intergovernmental Panel on Climate
 Change (IPCC), 304, 316, 339, 340,
 341, 350, 354–356
- Interphase, **28**, 29–30
- Intestines, 54, 55, **58**, 376–377
- Inuit, 290
- In vitro fertilization (IVF), 117–118
- Ionic compounds, **156**, 156–158, 169
 formulas for, 162–163
 models of, 169
 naming, 159–164
 reactions in solution, 231

- ions, **149**
 charges, 149
 lithium, 154–155
 names, 157–158
 polyatomic, 160–161
 symbols, 157–158
- IPCC. *See* Intergovernmental Panel on Climate Change (IPCC)
- Iris, **470**, 484
- Iron, 154
- J**
- Jenner, Edward, 102
- Jet streams, 283
- K**
- Kidneys, 55, 71, 83, 113
- Kinetic energy, 279
- Kyoto Protocol, **342**, 354
- L**
- Lakes, acidic, 209, 210, 214–215
- Laser eye surgery, **475**, 480
- Lasers, 377, 432, **490**
- Latitude, 276, 278
- Lavoisier, Antoine and Marie-Anne, 184
- Law of conservation of mass, **176**
- Law of reflection, **418**
- Leaves, 59, 72
- Leeuwenhoek, Antony van, 487
- Length, 534
- Lenses, **450**. *See also* Concave lenses;
 Convex lenses; Eyeglasses
 camera, 484, 485
 contact, 469, 473, 474, 476
 corrective, 473–476
 of eyes, 470, 471
 of microscope, 542–544
 ray diagrams for, 451–452, 454, 458
 of telescopes, 482–483
 terminology of, 450
 thin, 454–457, 483, 551
 types of, 450
- Lifestyle. *See* Everyday life
- Light
 absorption of, 404
 additive colour theory of, 387
 bending of, 436
 and colour, 380–381
 component colours of, 389
 detection of, 472
 focussing, 471
 human perception of, 468–481
 interacting with, 402–403
 and matter, 404–405
 predicting behaviour of, 403
 properties of, 407
 ray model of, 402–409
 reflection of, 404, 406
 sources of, 393, 394–396, 400
 speed of, 436–437
 subtractive colour theory of, 388, 389
 transmission of, 404
 visible, 384
 wave model of, 386–387
- Light-emitting diodes (LEDs), **397**,
 397–398
- Lime, 209
- Line graphs, 540–541
- Lipids, 12, 16
- Lippershey, Hans, 482
- Liquid crystal display (LCD), **398**, 399
- Liquid crystals, **398**
- Lithium, 154–155
- Lithosphere, **266**, 266–267
- Litmus, 197
- Liver, 54, 55, 195
 green, 84
 regeneration of, 38
- Lockridge, Ada, 152
- Lungs, 54, 55, **57**
- Lymphatic system, 67
- Lysosomes, **13**
- M**
- Magnetic resonance imaging (MRI), 92,
 97, 100
- Magnification, **423**, 549
 in concave mirrors, 423–425
 of microscopes, 18, 22, 542–543
- Mantle, 266
- Marketplaces, 320
- Mass
 chemical reactions and, 184–185
 conservation of, 176–177
 density, 445
 measurement of, 535–536
- Material Safety Data Sheet (MSDS), 237
- Matter, **142**, 142–143
 atoms and, 144–145
 chemical properties of, 142–143
 light and, 404–405
 physical properties of, 142
- McCulloch, Ernest, 61
- Measles, mumps, and rubella (MMR), 105,
 109
- Measurement, 532–537
- Mechanical mixtures, **143**
- Media, **436**
- Media messages, 110
- Medical imaging, **93**, 94–99
- Medical laboratory technologists, 49
- Mendeleev, Dmitri, 146
- Meristematic cells, 33, **41**
- Meristematic tissue, **43**, 59, 60
- Mesophyll, **44**, 59
- Mesosphere, 265–266
- Metalloids, **146**
- Metals, **146**
- Metaphase, **32**
- Meteorologists, 260
- Methane, 227, 298, 299, 301
- Micrographs, 18
- Microscopes, 484, 487
 and cells, 8–9, 16–20, 21, 22, 24
 using, 542–545
- Microwaves, **384**
- Mine sites, contamination at, 211
- Mirages, **443**, 497
- Mirrors, 416–417
 concave, 421–425
 convex, 426–427
 curved, 420–427
 images in, 417
 two-way, 457
- Mitigation, **350**
 of greenhouse gas emissions, 350–354
- Mitochondria, **13**
- Mitosis, **28**, 30–31, 33, 35
- Mitotic spindle, 31, 32
- Mixtures, **143**
- Models, **386**
 of albedo, 288
 of climate change, 338–340
 computer, 338–340
 of ionic compounds, 169
 of molecules, 170
 of natural and anthropogenic green-
 house effects, 306
 wave model of light, 386–387
- Molecular compounds, **165**, 165–168
- Molecular elements, **164**, 164–165
- Molecules, **164**
 and formula equations, 175
 modelling, 170
- Multivalent elements, **158**, 159–160
- Muscle tissue, 42
- Muscular system, 65, 66, 67, 81
- Mutations, of cells, 34
- N**
- Names and naming
 acids, 199
 bases, 201
 binary molecular compounds, 167–168

- ion, 158
 ionic compounds, 159–164
 Natural greenhouse effect, **276**, 276–277, 298, 306
 Near-sightedness, **474**
 Nephrons, 71
 Nervous system, 65, 66, 67, 81
 Nervous tissue, 42–43
 Net radiation budget, **277**, 277–278, 281, 282
 Neutrality, 144, **196**
 Neutralization, **206**, 206–207
 Neutralization reactions, 213
 applications of, 207
 and double displacement reactions, 236
 and environment, 208–212
 GCE for, 224
 Neutrons, **144**
 Newton, Isaac, 483
 Nitrogen dioxide, 208
 Nitrous oxide, 298, 301
 Noble gases, **148**
 Non-metals, **146**
 Normal, **418**, 439
 Nuclear medicine, 98
 Nucleus
 of atom, **144**
 of cell, **12**, 12–13
 Nutrition, 109
- O**
- Oceans, 285, 312–313. *See also* Arctic Ocean
 acidity of, 317
 bioluminescence in, 392
 currents, 285, 314–315
 melting ice and, 312–313
 salinity of, 314–315
 warming of, 313
 Oil
 consumption, 356
 as fossil fuel, 301
 spills, 232
 Ontario
 acid spills in, 212
 albedo in, 278
 chemical industry in, 140–141, 152
 Climate Change Secretariat, 345
 contamination at mine sites, 211
 Drive Clean program, 350
 Go Green plan, 344, 345
 lakes in, 209, 210
 Ministry of Health and Long Term Care, 104
 storms in, 311
- Opaque, defined, **404**
 Ophthalmologists, **469**
 Optical computers, 492
 Optical devices, 377, **418**
 Optical fibres, **434**. *See also* Fibre optics
 Opticians, 411
 Optic nerve, **472**
 Optics, 549–551
 Optometrists, **469**
 Organelles, **10**, 11–15
 Organic light-emitting display (OLED), **397**
 Organs, **54**, 54–55
 animal, 56–58
 growing of replacement, 39
 mapping, 55
 medical imaging of, 94–99
 plant, 59–60
 transplanting of, 55, 87, 112–113
 Organ systems, 64–65, **65**
 of animals, 66–71
 diagnosing problems in, 82–84
 environmental changes and, 85
 interdependence of, 80–81
 of plants, 72
 Ovaries, of plants, 60
 Oxyacetylene torches, 230–231
 Oxygen
 in circulatory system, 71
 in photosynthesis, 59
 in respiratory system, 57, 69
 Ozone, 165
- P**
- Pancreas, 55, 195
 Pandemics, 4–5
 Penumbra, **405**
 Periodic table of elements, 146–150
 Periods, **146**
 Peristalsis, 58
 Permafrost, 310
 Persistence, **298**
 PH, 196–197, 198, 202
 of food products, 207
 of household liquids, 202
 of lake water, 209
 plants and, 204–205
 of soil, 204–205, 207, 208
 Phloem, **45**
 Phosphorescence, **395**
 Phosphoric acid, 217
 Phosphors, **394**, 449
 Photonics, **491**, 491–492
 Photons, **491**
 Photoreceptors, **472**
- Photosynthesis, 15, 16, 44, 45, 59, 264, 277, 302, 342
 PH paper, 197
 PH scale, **196**
 Physical properties, **142**
 Phytoplankton, 313
 Phytoremediation, 84
 Pigments, 388
 Pistil, 60
 Pixels, 398, 486, **486**
 Plane mirrors, 403, **419**, 428
 Plants. *See also* Photosynthesis
 cells, 10, 14–15
 cloning of, 115
 organs, 59–60
 organ systems of, 72
 pH and, 204–205
 tissues, 43–44, 46
 transgenic, 116, 119
 Plasma display, **398**, 399
 Platelets, 42
 Plate tectonics, 267
 Pollen, 60
 Polyatomic ions, **160**, 163–164, 199
 Polymer chemists, 189
 Positive feedback loop, **326**
 Positron emission tomography (PET), 98
 Precipitates, **206**, 207
 Prevention programs, 104
 Prisms, **386**
 Products, **174**, 174–175
 counting atoms in, 176–177
 Properties, **386**
 of acids, 198
 chemical, 142–143
 of images, 461
 of light, 407
 of molecular compounds, 166
 physical, 142
 of waves, 382
 Prophase, **31**
 Proteins
 and chromosomes, 28–29
 green fluorescent (GFP), 136–137
 Protons, **144**
 Public health strategies, **104**, 104–109
 accessing programs, 118
 Pupil, **470**, 484
 Pure substances, **143**
 Pyloric caecum, 69
- Q**
- Quarantine, 4, 5

R

Radiation, **279**
 Radiographs, 94–95
 Radioisotopes, 98
 Radiologists, 94
 Radiotherapy, 95
 Radio waves, **384**
 Ray diagrams
 for concave mirrors, 422, 429
 for convex lenses, 458
 for convex mirrors, 426, 429
 for lenses, 451–452, 454
 for shadows, 405, 408
 Ray model of light, 402–409, **404**
 Reactants, **174**, 174–175
 counting atoms in, 176–177
 Reading, 524–525
 Real image, **420**
 Rectum, 58
 Red blood cells, **42**, 83
 Reflect, defined, 388
 Reflecting telescopes, **489**
 Reflection
 law of, 418–419
 of light, 404, 406
 Reflection of light, 404
 Refracting telescopes, **488**, 488–489
 Refraction, 434–437, **436**
 Regeneration, **38**, 38–39
 Regular reflection, **406**
 Renewable energy sources, 352, 356
 Reproductive system, 67
 Reproductive technologies, 117–118
 Research, 520–523
 Respiratory system, 66, 67, **69**, 69–70, 81
 Rest position, **382**
 Retina, **471**, 490
 Retinal implants, **476**
 Ribosomes, **14**
 Rod cells, **472**
 Roots, 59
 Root system, 72
 Rough endoplasmic reticulum, **14**
 Runaway positive feedback loop, **327**

S

Safety symbols, 511
 Salinity, **314**, 314–315
 Salmonella bacteria, 121
 SARS (severe acute respiratory syndrome), 48
 Scientific diagrams, 545
 Scientific notation, 533
 Screening programs, 108
 Scrubbers, 209–210

Sequestering, **350**
 of carbon dioxide, 353
 of greenhouse gases, 350
 Shadows, 405, 408
 Shells, of atom, **144**. *See also* Valence shells
 Shoot system, 72
 Shutter, of camera, **484**
 Significant digits, 532
 Silver, Joshua, 463
 Singer, Robert D., 188
 Single displacement reactions, **233**, 239
 Sister chromatids, **29**, 31, 32
 SI units, 533–534
 Skeletal system, 66, 67, 81
 Skeleton equations, **178**, 178–180
 Skin, 26–27, **56**
 cancer, 107, 109
 in excretory system, 71
 and integumentary system, 68
 as organ, 55, 56
 Smelting, 222–223
 Smith, George E., 410
 Smoking, 106
 Smooth endoplasmic reticulum, **14**
 Snell's law, **441**, 441–442, 550
 Societies, climate change and, 321, 323–325
 Soil(s)
 acidity of, 204–205, 207
 pH of, 204–205, 207, 208
 restoration of, 211–212
 Solar cells, 492
 Solar ovens, **423**
 Solar radiation, **264**, 275, 277, 278, 279, 327
 Solubility, of compounds, 155
 Sound waves, 96
 Stamens, 60
 Steel, 222–223
 Stem, of plant, 60
 Stem cells, **40**, 40–41, 61
 Stomach, 54, 55, **58**, 195, 197, 207, 376–377
 Stomata, **44**, 59, 72
 Storms, 311, 313, 314, 339, 354
 Stratosphere, 265–266
 Strickland, Dan, 315
 Subatomic particles, **144**
 Subtractive colour theory, **388**, 389
 Sulphur, 145
 Sulphur dioxide, 208, 225
 Sulphuric acid, 199, 208, 212
 Sun, 55, 107, 109, 264, 403
 Sun protection factor (SPF), 406

Suspension, **143**
 Sustainable development, **342**
 Synthesis reactions, **225**, 225–226, 228

T

Technology
 for adaptation to climate change, 354–356
 cell biology, 114–118
 medical imaging, 92–99, 100
 optical, 376–377
 problem-solving process for development of, 516–517
 and scientific knowledge, 9
 Telephoto lenses, **485**
 Telescopes, 377, 482–483, 484, **488**, 488–489
 Televisions, 398–399
 Telophase, **32**
 Temperature, measuring, 537
 Thermal energy, **264**, 276
 Thermal energy transfer, 279–280
 in atmosphere, 280–283
 in hydrosphere, 284–285
 Thermosphere, 265–266
 Thin lens, **452**
 Thin lens equation, **454**, 454–457, 551
 Thylakoids, **15**
 Till, James, 61
 Tissues, **42**, 42–45, 46, 55
 medical imaging of, 94–99
 Tongue, 58
 Toronto
 heat waves in, 310
 latitude of, 276
 weather stations in, 270
 Total internal reflection, **442**, 442–443
 Trachea, 57, 69
 Transducers, 96
 Transgenic organisms, **116**
 Transgenics, issues regarding, 119
 Translucent, defined, **404**
 Transparent, defined, **404**
 Transpiration, **72**
 Transportation
 decisions regarding, 359
 fossil fuels and, 322, 352
 of goods, 322, 327
 ice melting and, 359
 Tree rings, 296–297
 Triboluminescence, **396**
 Troposphere, 265–266
 Troughs, of waves, **382**
 Tyndall, John, 299

U

Ultrasound imaging, 92, 96
 Ultraviolet rays, **385**
 Ultraviolet (UV) radiation, 27, 56, 107, 390, 394, 491
 Umbra, **405**
 United Nations Framework Convention on Climate Change (UNFCCC), 341–342
 Universal indicators, **197**
 Urine, 71, 83, 194

V

Vaccinations, 102–103, 105–106, 109
 Vacuoles, **13**, 16
 Valence electrons, **145**
 Valence shells, **145**
 Van Leeuwenhoek, Antony. *See* Leeuwenhoek, Antony van
 Vascular tissue, 45, 59, 60
 Vehicles
 biofuel, 359
 chemistry and, 172–173
 electric, 352
 emissions from, 210, 359
 fuel-efficient, 352, 359
 mirrors and, 427
 Veins, 70
 Vertex, **420**
 Vesicles, **13**

Viganella (Italy), 416–417
 Virtual image, **419**
 Viruses, 102, 103, 107, 114
 Visible spectrum, **386**
 Vision. *See also* Eyes
 colour and, 477
 correction of problems with, 473–476.
 See also Lenses
 human, 470
 testing, 469
 Volcanoes, 267, 339, 361
 Volume, 535

W

Waste disposal, 348–349
 Water. *See also* Hydrosphere; Oceans
 in biosphere, 267
 calcium in, 151
 convection and, 280, 313
 cycle, 284
 in plants, 72
 vapour, 265, 284, 298
 Watt-Cloutier, Sheila, 290
 Wavelengths, **382**, 491
 of colours, 386
 reflection of, 388
 Wave model of light, **386**, 491
 Waves, **382**
 energy in, 382–383
 properties of, 382

Weather, **262**
 climate and, 262–263
 effects of, 260–261
 forecasts, 260–261, 262
 Weight, 535–536
 Welding, 230–231
 West Nile Virus, 107
 White blood cells, 42, 83
 White light, 380–381
 WHMIS symbols, 511
 Wide-angle lenses, **485**
 Wildfires, 311, 326
 Wildlife. *See* Animals
 Willson, Thomas L., 230–231
 Wind, **281**, 282–283, 285, 339
 Wind power, 352

X

X-rays, 92, 94–95, 376, **385**
 Xylem, **45**, 72

Y

Yanful, E.K., 141

Z

Zinc, 154
 Zur Hausen, Harald, 105–106

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Skills Reference

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Charts

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Periodic Table of the Elements

1	1		2																												
1	1 H hydrogen 1.01 1 ⁺										<table border="1"> <tr> <td>metal</td> <td>C solid</td> <td>atomic number — 8</td> <td>2 — ion charge (if more than one, first one is the most common)</td> </tr> <tr> <td>metalloid</td> <td>Br liquid</td> <td>symbol — O</td> <td></td> </tr> <tr> <td>non-metal</td> <td>He gas</td> <td>name — oxygen</td> <td></td> </tr> <tr> <td></td> <td></td> <td>atomic mass — 16.00</td> <td></td> </tr> </table>					metal	C solid	atomic number — 8	2 — ion charge (if more than one, first one is the most common)	metalloid	Br liquid	symbol — O		non-metal	He gas	name — oxygen				atomic mass — 16.00	
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3	11 Na sodium 22.99 1 ⁺	12 Mg magnesium 24.31 2 ⁺	3	4	5	6	7	8	9																						
4	19 K potassium 39.10 1 ⁺	20 Ca calcium 40.08 2 ⁺	21 Sc scandium 44.96 3 ⁺	22 Ti titanium 47.87 4 ⁺ 3 ⁺	23 V vanadium 50.94 5 ⁺ 4 ⁺	24 Cr chromium 52.00 3 ⁺ 2 ⁺	25 Mn manganese 54.94 2 ⁺ 4 ⁺	26 Fe iron 55.85 3 ⁺ 2 ⁺	27 Co cobalt 58.93 2 ⁺ 3 ⁺																						
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6	55 Cs cesium 132.91 1 ⁺	56 Ba barium 137.33 2 ⁺	57–71	72 Hf hafnium 178.49 4 ⁺	73 Ta tantalum 180.95 5 ⁺	74 W tungsten 183.84 6 ⁺	75 Re rhenium 186.21 7 ⁺	76 Os osmium 190.23 4 ⁺	77 Ir iridium 192.22 4 ⁺																						
7	87 Fr francium (223) 1 ⁺	88 Ra radium (226) 2 ⁺	89–103	104 Rf rutherfordium (261) 4 ⁺	105 Db dubnium (262) 5 ⁺	106 Sg seaborgium (266) 6 ⁺	107 Bh bohrium (264) 7 ⁺	108 Hs hassium (277) 8 ⁺	109 Mt meitnerium (268) 9 ⁺																						
6											57 La lanthanum 138.91 3 ⁺	58 Ce cerium 140.12 3 ⁺	59 Pr praseodymium 140.91 3 ⁺	60 Nd neodymium 144.24 3 ⁺	61 Pm promethium (145) 3 ⁺	62 Sm samarium 150.36 3 ⁺ 2 ⁺	63 Eu europium 151.96 3 ⁺ 2 ⁺														
7											89 Ac actinium (227) 3 ⁺	90 Th thorium 232.04 4 ⁺	91 Pa protactinium 231.04 5 ⁺ 4 ⁺	92 U uranium 238.03 6 ⁺ 4 ⁺	93 Np neptunium (237) 5 ⁺	94 Pu plutonium (244) 4 ⁺ 6 ⁺	95 Am americium (243) 3 ⁺ 4 ⁺														

