

These pages include numerical and short answers to chapter section questions, tutorial practice questions, and Chapter Self-Quiz, Chapter Review, Unit Self-Quiz, and Unit Review questions.

### Unit 1

#### Are You Ready? pp. 4–5

- (a) compound (d) mixture  
(b) element (e) compound  
(c) mixture
- (c) F: halogens; Mg: alkaline earth metals;  
Xe: noble gases; Na: alkali metals
- (a) one (c) eight (except He)  
(b) seven (d) two
- (a) v (d) ii  
(b) vi (e) i  
(c) iii (f) iv

#### 1.1 Questions, p. 10

- (a) International Union of Pure and Applied Chemistry

#### 1.2 Questions, p. 16

- Ca – 2, C – 4, Si – 4
- 119 protons, 119 electrons, 183 neutrons

#### 1.3 Questions, p. 22

- (a) argon (c) neon  
(b) neon (d) neon
- (a) oxide (d) sulfate  
(b) copper(I) (e) hydroxide  
(c) tin(IV) (f) ammonium
- (a)  $\text{NO}_3^-$   
(b)  $\text{CO}_3^{2-}$   
(c)  $\text{C}_2\text{H}_3\text{O}_2^-$   
(d)  $\text{MnO}_4^-$
- $\text{Ca}^{2+}$ , cation;  $\text{CO}_3^{2-}$ , anion
- Ne,  $\text{Na}^+$ ,  $\text{Al}^{3+}$  and  $\text{O}^{2-}$
- conductivity test, flame test

#### 1.4 Questions, p. 29

- Ag-107
- 28.11 u
- Cl-35: 17 protons, 17 electrons, and 18 neutrons  
Cl-37: 17 protons, 17 electrons, and 20 neutrons
- 39.1 u

#### 1.5 Questions, p. 33

- (a) chlorine (c) silicon  
(b) krypton (d) rubidium
- (a) seven (e) eight  
(b) six (f) four  
(c) two (g) three  
(d) one
- (a) Cs more reactive than Ba  
(b) F more reactive than C  
(c) Na more reactive than Ar  
(d) Mg more reactive than Si

#### 1.7 Questions, p. 41

- (a) actinium (c) radon  
(b) cesium
- $\text{F} < \text{C} < \text{Li} < \text{K} < \text{Rb} < \text{Cs}$
- magnesium atom

#### Chapter 1 Self-Quiz, p. 47

- (b) 7. (a) 13. T
- (a) 8. (d) 14. F
- (c) 9. (c) 15. F
- (b) 10. T 16. F
- (d) 11. F 17. T
- (b) 12. F 18. T

#### Chapter 1 Review, p. 48

- (c) 7. (b) 13. F
- (a) 8. (d) 14. F
- (d) 9. (b) 15. T
- (a) 10. T 16. F
- (c) 11. F 17. T
- (b) 12. T 18. F
- (a) vi (d) ii  
(b) iii (e) i  
(c) iv (f) v
- (a) 13 (b) 27
- sharing, losing, or gaining electrons
- (a) Groups 1, 2, and 13 to 18
- (a) left side  
(b) right side  
(c) next to the staircase line
- picometre
- (a) the atomic mass unit, u
- (a) ion source, analyzer, and detector
- (a) fluorine  
(b) oxygen
- (a)  $\text{Fe}^{2+}$ ; ferrous, or iron(II), ion  
(b)  $\text{Fe}^{3+}$ ; ferric, or iron(III), ion
- (c)  $\text{IO}_4^-$
- 52.1 u
- (a) K-39
- 10.8 u
- (a) fluorine

#### 2.3 Questions, p. 73

- $\text{Cs} < \text{K} < \text{Ca} < \text{Fe} < \text{Br} < \text{Cl} < \text{F}$
- (a) 1.6, polar covalent  
(b) 1.8, ionic  
(c) 0, non-polar covalent  
(d) 0.6, polar covalent  
(e) 0.8, polar covalent  
(f) 2.2, ionic
- (a) H-F (c) C-N  
(b) O-H
- (a) non-polar (d) polar  
(b) non-polar (e) ionic  
(c) polar
- (a) Fr-F,  $\Delta EN = 3.3$

#### 2.4 Tutorial 1 Practice, p. 75

- (a) MgO (c)  $\text{K}_2\text{O}$   
(b)  $\text{AlF}_3$
- (a)  $\text{Mg}(\text{OH})_2$  (c)  $\text{AlPO}_4$   
(b)  $\text{NaHCO}_3$

#### 2.4 Tutorial 2 Practice, p. 77

- (a) copper(II) sulfate (c) tin(IV) chloride  
(b) copper(I) chloride (d) tin(II) oxide

#### 2.4 Tutorial 2 Practice, p. 78

- (a) lead(IV) sulfite  
(b) lead(II) nitrate  
(c) copper(I) phosphate  
(d) iron(III) hydroxide  
(e) sodium hypochlorite  
(f) ammonium carbonate

#### 2.4 Tutorial 3 Practice, p. 80

- (a) calcium chloride dihydrate  
(b)  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ , sodium sulfate decahydrate

#### 2.4 Tutorial 4 Practice, p. 80

- (a) carbon tetrachloride  
(b) nitrogen dioxide  
(c) diphosphorus pentoxide  
(d) carbon tetrafluoride
- (a) CO  
(b)  $\text{SO}_2$   
(c)  $\text{PF}_5$

#### 2.4 Questions, p. 81

- (a) LiCl (d)  $\text{Al}_2\text{O}_3$   
(b)  $\text{K}_2\text{S}$  (e)  $\text{Na}_2\text{SO}_4$   
(c)  $\text{FeCl}_2$  (f)  $\text{SnO}_2$
- (a) magnesium chloride  
(b) cesium oxide  
(c) iron(III) sulfide  
(d) sodium phosphate  
(e) ammonium nitrate  
(f) aluminum sulfate  
(g) magnesium chlorate  
(h) lead(II) bromate  
(i) zinc hydrogen phosphate  
(j) sodium cyanide
- (a) phosphorous pentachloride  
(b) dinitrogen pentoxide  
(c) carbon tetrafluoride  
(d) sulfur dioxide
- $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ ,  $\text{CoCl}_2$
- (a)  $\text{PCl}_3$  (c) CO  
(b)  $\text{CCl}_4$  (d) NO
- (a) potassium hydroxide  
(b) sodium nitrite  
(c) copper(I) chloride  
(d) sodium hydroxide  
(e) calcium carbonate

#### Chapter 2 Self-Quiz, p. 87

- (b) 8. (b) 15. T
- (c) 9. (c) 16. T
- (d) 10. F 17. F
- (a) 11. F 18. F
- (a) 12. T 19. F
- (c) 13. F 20. T
- (b) 14. F

**Chapter 2 Review, p. 88**

- (c) 8. (b) 15. T
- (c) 9. (d) 16. F
- (d) 10. (b) 17. F
- (d) 11. (d) 18. T
- (a) 12. F 19. F
- (b) 13. F 20. T
- (b) 14. T 21. F
- (a) iii (e) ii  
(b) iv (f) v  
(c) i (g) vi  
(d) vii
- (b)  $X_2Y_5$
- double bonds:  $CS_2$  and  $COCl_2$ ; triple bonds:  $HCN$  and  $NO^+$
- all except bromine,  $Br_2$
- (a) polar covalent  
(b) ionic  
(c) polar covalent  
(d) non-polar covalent  
(e) ionic
- (a)  $CuO$  (d)  $BaF_2$   
(b)  $Al(NO_3)_3$  (e)  $PbO_2$   
(c)  $MnCl_2$  (f)  $Fe_2(SO_4)_3$
- (a)  $CS_2$  (c)  $Cl_2O$   
(b)  $As_2O_3$  (d)  $Sb_2O_5$
- (a) strontium sulfide  
(b) ammonium sulfate  
(c) tin(II) fluoride  
(d) iron(III) phosphate  
(e) calcium hydroxide  
(f) magnesium carbonate
- (a) nitrogen trifluoride  
(b) diboron trioxide  
(c) diiodine pentoxide  
(d) bromine monoxide
- $Fe(NO_3)_3 \cdot 9H_2O$
- zinc chloride hexahydrate
- (c)  $C_2D$  (d) formula unit
- (a)  $C_{27}H_{46}O$

**3.3 Tutorial 1 Practice, p. 107**

- (a) polar (d) non-polar  
(b) non-polar (e) non-polar  
(c) polar (f) non-polar

**3.3 Questions, p. 108**

- (a) K-Br, H-Br, O-F, C-H  
(b) C-F, O-H, C-O, H-H
- (a) symmetrical (d) symmetrical  
(b) asymmetrical (e) asymmetrical  
(c) symmetrical
- (a) non-polar (d) non-polar  
(b) polar (e) polar  
(c) polar
- (a) non-polar (c) non-polar  
(b) polar (d) polar

**3.4 Questions, p. 115**

- (a) hydrogen bonding  
(b) dipole-dipole forces
- London dispersion forces, dipole-dipole forces, hydrogen bonds
- (a) London dispersion forces  
(b) London dispersion forces, dipole-dipole forces  
(c) London dispersion forces, hydrogen bonds  
(d) London dispersion forces  
(e) London dispersion forces, dipole-dipole forces
- $H_2$ ,  $CH_4$ ,  $C_3H_8$ ,  $CH_3Cl$ ,  $NH_3$ ,  $CH_3OH$ ,  $H_2O$

**Chapter 3 Self-Quiz, p. 127**

- (c) 8. (d) 15. F
- (b) 9. (a) 16. T
- (b) 10. F 17. T
- (a) 11. F 18. T
- (a) 12. T 19. F
- (d) 13. F 20. F
- (b) 14. T

**Chapter 3 Review, p. 128**

- (c) 9. (a) 17. F
- (d) 10. (c) 18. T
- (a) 11. (b) 19. F
- (c) 12. T 20. F
- (d) 13. T 21. F
- (a) 14. F 22. T
- (d) 15. T
- (a) 16. F
- (a) i (b) iii (c) ii
- food, fuel, and medicines
- glass, metal, plastic, and paper
- (a) covalent bonds  
(b) ionic bonds  
(c) ionic bonds  
(d) covalent bonds  
(e) covalent bonds
- (a) N-F, H-Br, Cl-Cl  
(b) As-O, C-N, C-S
- (a)  $\delta^+ N-F \delta^-$   
(b)  $\delta^+ As-O \delta^-$
- (a) force 1: polar covalent bond; force 2: dipole-dipole force

**Unit 1 Self-Quiz, p. 136**

- (b) 15. (d) 29. F
- (c) 16. (b) 30. T
- (c) 17. (a) 31. F
- (a) 18. (d) 32. T
- (a) 19. (b) 33. T
- (d) 20. (c) 34. T
- (a) 21. (d) 35. F
- (b) 22. F 36. T
- (c) 23. T 37. F
- (d) 24. T 38. F
- (d) 25. F 39. T
- (c) 26. F 40. T
- (a) 27. T 41. F
- (a) 28. F

**Unit 1 Review, p. 138**

- (b) 9. (a) 17. F
- (c) 10. (b) 18. T
- (b) 11. (c) 19. T
- (b) 12. (b) 20. F
- (a) 13. T 21. T
- (d) 14. F 22. T
- (a) 15. F 23. T
- (d) 16. F 24. F
- (a) iii  
(b) ii  
(c) i  
(d) iv
- (a)  $Br^-$  (d)  $Mg^{2+}$   
(b)  $N^{3-}$  (e)  $S^{2-}$   
(c)  $K^+$
- (a) sulfate (e) perchlorate  
(b) nitrate (f) cyanide  
(c) carbonate (g) sulfite  
(d) bromate

- (a)  $ClO_3^-$  (e)  $Cr_2O_7^{2-}$   
(b)  $NH_4^+$  (f)  $MnO_4^-$   
(c)  $HCO_3^-$  (g)  $HSO_4^-$   
(d)  $ClO^-$
- (a) sodium bromide  
(b) magnesium sulfide  
(c) copper(I) hydroxide  
(d) tin(II) chloride  
(e) potassium sulfite
- (a) sulfur trioxide  
(b) arsenic trichloride  
(c) nitrogen monoxide  
(d) carbon tetrachloride  
(e) diphosphorus pentoxide
- (a)  $NaF$  (f)  $Mg(NO_3)_2$   
(b)  $CaCl_2$  (g)  $Ba_3(PO_4)_2$   
(c)  $Hg_2O$  (h)  $MgSO_3$   
(d)  $KCN$  (i)  $Ni(ClO_4)_2$   
(e)  $(NH_4)_2SO_4$  (j)  $Cu_2S$
- (a)  $SO_2$  (d)  $PCl_3$   
(b)  $Cl_4$  (e)  $N_2O_4$   
(c)  $SiO_2$
- (a) dipole-dipole forces, London dispersion forces, and hydrogen bonds.  
(b) dipole-dipole forces and London dispersion forces
- (a) mercury(I) chloride  
(b) mercury(II) oxide  
(c) mercury(I) nitrate
- $2.4 \times 10^2 u$
- (a) polar covalent bond  
(b) polar covalent bond  
(c) ionic bond  
(d) non-polar covalent bond  
(e) polar covalent bond

**Unit 2****Are You Ready? pp. 148-149**

- (a) colour change  
(b)  $CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$   
(c) bubbles of gas  
(d) oxygen  
(e)  $2 H_2O_2(aq) \rightarrow 2 H_2O(l) + O_2(g)$   
(f) changes in energy, precipitate formation
- (a)  $CH_4(g) + 2 O_2(g) \rightarrow CO_2(g) + 2 H_2O(g)$   
(e) 36 g
- (a) metal (b)  $XCl_2$   
(c) group 2
- (a)  $K_2S$  (f)  $CS_2$   
(b)  $NH_4ClO_3$  (g)  $KH_2PO_4$   
(c)  $Na_2SO_3$  (h)  $Ba(ClO)_2$   
(d)  $Fe(NO_2)_3$  (i)  $MnSO_4$   
(e)  $Ca_3(PO_4)_2$  (j)  $NH_4ClO_4$
- (a) aluminum chloride  
(b) zinc chlorate  
(c) lead(IV) oxide  
(d) ammonium carbonate  
(e) sodium phosphite  
(f) calcium hydrogen carbonate  
(g) zinc chlorite  
(h) sulfur dioxide  
(i) dinitrogen monoxide  
(j) iron(III) hydroxide
- (a)  $4 K + O_2 \rightarrow 2 K_2O$   
(b)  $P_4 + 6 Cl_2 \rightarrow 4 PCl_3$   
(c)  $C_3H_8 + 5 O_2 \rightarrow 3 CO_2 + 4 H_2O$   
(d)  $2 Fe + 3 H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3 H_2$   
(e)  $2 HBr + Mg(OH)_2 \rightarrow MgBr_2 + 2 H_2O$

- (f)  $2\text{Na}_3\text{PO}_4 + 3\text{CaF}_2 \rightarrow 6\text{NaF} + \text{Ca}_3(\text{PO}_4)_2$   
 (g)  $4(\text{NH}_4)_3\text{PO}_4 + 3\text{Sn}(\text{NO}_3)_4 \rightarrow \text{Sn}_3(\text{PO}_4)_4 + 12\text{NH}_4\text{NO}_3$
8. (a) pink sample on the right  
 (b)  $\text{NaHCO}_3$   
 (c) raise the pH
9. (a) able to neutralize acids, be safe to handle  
 (b)  $\text{NaHCO}_3(\text{aq})$

#### 4.1 Tutorial 1 Practice, p. 155

1. (a)  $4\text{P} + 5\text{O}_2 \rightarrow 2\text{P}_2\text{O}_5$   
 (b)  $\text{K}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{KOH}$   
 (c)  $2\text{AlBr}_3 + 3\text{K}_2\text{SO}_4 \rightarrow 6\text{KBr} + \text{Al}_2(\text{SO}_4)_3$   
 (d)  $\text{FeCl}_3 + 3\text{NaOH} \rightarrow \text{Fe}(\text{OH})_3 + 3\text{NaCl}$   
 (e)  $2\text{AgNO}_3 + \text{H}_2\text{S} \rightarrow \text{Ag}_2\text{S} + 2\text{HNO}_3$   
 (f)  $(\text{NH}_4)_2\text{CO}_3 \rightarrow 2\text{NH}_3 + \text{H}_2\text{O} + \text{CO}_2$

#### 4.1 Questions, p. 155

3. (a) copper metal + nitric acid  $\rightarrow$  nitrogen dioxide + water + copper(II) nitrate  
 (b)  $2\text{Cu}(\text{s}) + 4\text{HNO}_3(\text{aq}) \rightarrow 2\text{NO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 2\text{Cu}(\text{NO}_3)_2(\text{aq})$   
 (c) 3  
 (d) 4  
 (e) 12  
 (f) (l) is liquid; (aq) means aqueous or "in water"
5. (a)  $\text{S}_8 + 8\text{O}_2 \rightarrow 8\text{SO}_2$   
 (b)  $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$   
 (c)  $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$   
 (d)  $3\text{Li} + \text{AlCl}_3 \rightarrow 3\text{LiCl} + \text{Al}$   
 (e)  $2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$   
 (f)  $2\text{N}_2 + 5\text{O}_2 \rightarrow 2\text{N}_2\text{O}_5$   
 (g)  $6\text{Li} + \text{B}_2\text{O}_3 \rightarrow 3\text{Li}_2\text{O} + 2\text{B}$   
 (h)  $\text{Fe}_2\text{O}_3 + 3\text{H}_2\text{SO}_4 \rightarrow \text{Fe}_2(\text{SO}_4)_3 + 3\text{H}_2\text{O}$   
 (i)  $2\text{H}_3\text{PO}_4 + 3\text{Ca}(\text{OH})_2 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 6\text{H}_2\text{O}$   
 (j)  $4\text{NH}_3 + 3\text{O}_2 \rightarrow 2\text{N}_2 + 6\text{H}_2\text{O}$   
 (k)  $\text{Ca}_3(\text{PO}_4)_2 + \text{SiO}_2 + \text{C} \rightarrow 3\text{CaSiO}_3 + \text{CO} + 2\text{P}$   
 (l)  $2\text{C}_6\text{H}_6 + 15\text{O}_2 \rightarrow 12\text{CO}_2 + 6\text{H}_2\text{O}$

#### 4.2 Tutorial 1 Practice, p. 157

- (a)  $\text{Ca}(\text{s}) + \text{Br}_2(\text{l}) \rightarrow \text{CaBr}_2(\text{s})$   
 (b)  $4\text{Al}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{Al}_2\text{O}_3(\text{s})$

#### 4.2 Questions, p. 161

2. (a)  $\text{Zn} + \text{S} \rightarrow \text{ZnS}$   
 (b)  $\text{CaCl}_2 \rightarrow \text{Ca} + \text{Cl}_2$   
 (c)  $\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_4\text{Cl}$   
 (d)  $2\text{K}_2\text{O} \rightarrow 4\text{K} + \text{O}_2$   
 (e)  $2\text{AlCl}_3 \rightarrow 2\text{Al} + 3\text{Cl}_2$   
 (f)  $\text{Mg}(\text{OH})_2 \rightarrow \text{H}_2\text{O} + \text{MgO}$
3. (a) oxygen  
 (b) decomposition  
 (c)  $2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$
4. (a)  $4\text{Al}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{Al}_2\text{O}_3(\text{s})$   
 (b)  $\text{CuCO}_3(\text{s}) \rightarrow \text{CuO}(\text{s}) + \text{CO}_2(\text{g})$   
 (c)  $2\text{NI}_3(\text{s}) \rightarrow \text{N}_2(\text{g}) + 3\text{I}_2(\text{g})$
6. (a)  $\text{S}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g})$   
 (b)  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$   
 (c)  $\text{SO}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{SO}_4(\text{aq})$
7. (a) carbon dioxide  
 (b)  $2\text{NaHCO}_3(\text{s}) \rightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{H}_2\text{O}(\text{g}) + \text{CO}_2(\text{g})$
8. (a) decomposition  
 (b) oxygen  
 (c) mercury  
 (d) mercury(III) oxide,  $\text{HgO}$   
 (e)  $2\text{HgO}(\text{s}) \rightarrow 2\text{Hg}(\text{l}) + \text{O}_2(\text{g})$
9. (a)  $2\text{NaN}_3(\text{s}) \rightarrow 3\text{N}_2(\text{g}) + 2\text{Na}(\text{g})$

#### 4.4 Tutorial 1 Practice, p. 166

1. (a)  $\text{Mg}(\text{s}) + 2\text{AgNO}_3(\text{aq}) \rightarrow 2\text{Ag}(\text{s}) + \text{Mg}(\text{NO}_3)_2(\text{aq})$   
 (b)  $\text{Zn}(\text{s}) + \text{FeCl}_2(\text{aq}) \rightarrow \text{Fe}(\text{s}) + \text{ZnCl}_2(\text{aq})$   
 (c)  $\text{Ni}(\text{s}) + \text{Al}(\text{NO}_3)_3 \rightarrow$  no reaction

#### 4.4 Tutorial 1 Practice, p. 167

2. (a)  $\text{Ca}(\text{s}) + 2\text{HBr}(\text{aq}) \rightarrow \text{H}_2(\text{g}) + \text{CaBr}_2(\text{aq})$   
 (b)  $\text{Cu}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow$  no reaction  
 (c)  $\text{Ba}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2(\text{g}) + \text{Ba}(\text{OH})_2(\text{aq})$   
 (d)  $\text{Hg}(\text{l}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow$  no reaction

#### 4.4 Questions, p. 169

2. (a)  $\text{Al}(\text{s}) + 3\text{AgNO}_3(\text{aq}) \rightarrow 3\text{Ag}(\text{s}) + \text{Al}(\text{NO}_3)_3(\text{aq})$   
 (b)  $\text{Zn}(\text{s}) + \text{Pb}(\text{NO}_3)_2(\text{aq}) \rightarrow \text{Pb}(\text{s}) + \text{Zn}(\text{NO}_3)_2(\text{aq})$   
 (c)  $\text{Au}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow$  no reaction  
 (d)  $\text{Mg}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{H}_2(\text{g}) + \text{MgSO}_4(\text{aq})$   
 (e)  $\text{Ca}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2(\text{g}) + \text{Ca}(\text{OH})_2(\text{aq})$   
 (f)  $2\text{Al}(\text{s}) + 6\text{HCl}(\text{aq}) \rightarrow 3\text{H}_2(\text{g}) + 2\text{AlCl}_3(\text{aq})$
3. (a)  $\text{Br}_2(\text{l}) + 2\text{NaI}(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + 2\text{NaBr}(\text{aq})$   
 (b)  $\text{Cl}_2(\text{g}) + \text{KF}(\text{aq}) \rightarrow$  no reaction  
 (c)  $\text{F}_2(\text{g}) + \text{CaBr}_2(\text{aq}) \rightarrow \text{Br}_2(\text{aq}) + \text{CaF}_2(\text{aq})$
6. (a)  $2\text{Mg}(\text{s}) + \text{CO}_2(\text{s}) \rightarrow 2\text{MgO}(\text{s}) + \text{C}(\text{s})$

#### 4.6 Tutorial 1 Practice, p. 175

1. (a)  $\text{Na}_2\text{S}(\text{aq}) + \text{Pb}(\text{NO}_3)_2(\text{aq}) \rightarrow \text{PbS}(\text{s}) + 2\text{NaNO}_3(\text{aq})$   
 (b)  $\text{NH}_4\text{Cl}(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) \rightarrow$  no reaction  
 (c)  $2\text{FeCl}_3(\text{aq}) + 3\text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{Fe}_2(\text{CO}_3)_3(\text{s}) + 6\text{NaCl}(\text{aq})$

#### 4.6 Questions, p. 177

2. (a) double displacement  
 (b) single displacement  
 (c) double displacement  
 (d) single displacement
3. (a)  $\text{PbSO}_4$ , slightly soluble  
 (b)  $(\text{NH}_4)_3\text{PO}_4$ , very soluble  
 (c)  $\text{CaSO}_4$ , slightly soluble  
 (d)  $\text{Al}_2(\text{SO}_4)_3$ , very soluble  
 (e)  $\text{Ca}_3(\text{PO}_4)_2$ , slightly soluble  
 (f)  $\text{BaSO}_4$ , slightly soluble  
 (g)  $(\text{NH}_4)_2\text{CO}_3$ , very soluble  
 (h)  $\text{CaCO}_3$ , slightly soluble
4. (a)  $\text{ZnCl}_2(\text{aq}) + 2\text{KOH}(\text{aq}) \rightarrow \text{Zn}(\text{OH})_2(\text{s}) + 2\text{KCl}(\text{aq})$   
 (b)  $\text{Ni}(\text{NO}_3)_2(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{NiCO}_3(\text{s}) + 2\text{NaNO}_3(\text{aq})$   
 (c)  $\text{Ba}(\text{OH})_2(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2\text{KOH}(\text{aq})$   
 (d)  $3\text{FeSO}_4(\text{aq}) + 2\text{K}_3\text{PO}_4(\text{aq}) \rightarrow \text{Fe}_3(\text{PO}_4)_2(\text{s}) + 3\text{K}_2\text{SO}_4(\text{aq})$   
 (e)  $\text{ZnS}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{H}_2\text{S}(\text{g}) + \text{ZnCl}_2(\text{aq})$   
 (f)  $\text{CaCO}_3(\text{s}) + 2\text{HNO}_3(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{Ca}(\text{NO}_3)_2(\text{aq})$   
 (g)  $\text{MgSO}_3(\text{aq}) + 2\text{HCl}(\text{aq}) \rightarrow \text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{MgCl}_2(\text{aq})$
5. (a)  $2\text{AgNO}_3(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) \rightarrow \text{Ag}_2\text{SO}_4(\text{s}) + 2\text{KNO}_3(\text{aq})$   
 (b)  $\text{NH}_4\text{Cl}(\text{aq}) + \text{Na}_2\text{S}(\text{aq}) \rightarrow$  no reaction  
 (c)  $3\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2\text{Na}_3\text{PO}_4(\text{aq}) \rightarrow \text{Pb}_3(\text{PO}_4)_2(\text{s}) + 6\text{NaNO}_3(\text{aq})$   
 (d)  $\text{BaCl}_2(\text{aq}) + \text{Ca}(\text{OH})_2(\text{aq}) \rightarrow$  no reaction

- (e)  $\text{CuSO}_4(\text{aq}) + \text{K}_2\text{CO}_3(\text{aq}) \rightarrow \text{CuCO}_3(\text{s}) + \text{K}_2\text{SO}_4(\text{aq})$
6. (a)  $\text{BaCO}_3(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{BaSO}_4(\text{s})$   
 (b)  $4\text{HF}(\text{aq}) + \text{SiO}_2(\text{s}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{SiF}_4(\text{aq})$   
 (c)  $\text{Ni}(\text{NO}_3)_2(\text{aq}) + \text{K}_2\text{CO}_3(\text{aq}) \rightarrow \text{NiCO}_3(\text{s}) + 2\text{KNO}_3(\text{aq})$   
 (d)  $\text{H}_2\text{SO}_4(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{Na}_2\text{SO}_4(\text{aq})$   
 (e)  $2\text{HCl}(\text{aq}) + \text{ZnS}(\text{s}) \rightarrow \text{H}_2\text{S}(\text{g}) + \text{ZnCl}_2(\text{aq})$

#### Chapter 4 Self-Quiz, p. 183

- |        |         |       |
|--------|---------|-------|
| 1. (b) | 7. (d)  | 13. F |
| 2. (d) | 8. (a)  | 14. T |
| 3. (a) | 9. (b)  | 15. F |
| 4. (c) | 10. (d) | 16. F |
| 5. (c) | 11. F   | 17. F |
| 6. (a) | 12. T   |       |

#### Chapter 4 Review, p. 184

- |        |         |       |
|--------|---------|-------|
| 1. (a) | 8. (d)  | 15. T |
| 2. (b) | 9. (b)  | 16. F |
| 3. (d) | 10. (d) | 17. F |
| 4. (a) | 11. F   | 18. F |
| 5. (d) | 12. F   | 19. T |
| 6. (c) | 13. F   |       |
| 7. (b) | 14. F   |       |
20. (a) iv (c) ii  
 (b) i (d) iii
39. (a)  $2\text{NaClO}_3(\text{s}) \rightarrow 2\text{NaCl}(\text{s}) + 3\text{O}_2(\text{g})$   
 (b)  $2\text{C}_2\text{H}_2(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g}) + 4\text{CO}_2(\text{g})$   
 (c)  $2\text{Na}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$
40. (a)  $\text{Ca}(\text{s}) + 2\text{HNO}_3(\text{aq}) \rightarrow \text{H}_2(\text{g}) + \text{Ca}(\text{NO}_3)_2(\text{aq})$   
 (b)  $2\text{Fe}(\text{NO}_3)_3(\text{aq}) + 3(\text{NH}_4)_2\text{CO}_3(\text{aq}) \rightarrow \text{Fe}_2(\text{CO}_3)_3(\text{s}) + 6\text{NH}_4\text{NO}_3(\text{aq})$   
 (c)  $2\text{AgNO}_3(\text{aq}) + \text{K}_2\text{CrO}_4(\text{aq}) \rightarrow \text{Ag}_2\text{CrO}_4(\text{s}) + 2\text{KNO}_3(\text{aq})$
41.  $\text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) + \text{energy}$
43. (a) decomposition (c) synthesis  
 (b) synthesis (d) decomposition
44. (a)  $2\text{HgO} \rightarrow 2\text{Hg} + \text{O}_2$   
 (b)  $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$   
 (c)  $2\text{NH}_3 \rightarrow \text{N}_2 + 3\text{H}_2$
45. (a) carbon dioxide  
 (b)  $\text{Ag}_2\text{CO}_3 \rightarrow \text{Ag}_2\text{O} + \text{CO}_2$
46.  $2\text{H}_2\text{O} \rightarrow \text{O}_2 + 2\text{H}_2$
50. (a)  $2\text{Al}(\text{s}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Al}_2(\text{SO}_4)_3(\text{aq}) + 3\text{H}_2(\text{g})$   
 (b)  $\text{Zn}(\text{s}) + \text{Cu}(\text{NO}_3)_2(\text{aq}) \rightarrow \text{Cu}(\text{s}) + \text{Zn}(\text{NO}_3)_2(\text{aq})$   
 (c) no reaction
51. (a) single displacement  
 (b)  $\text{Cl}_2(\text{g}) + 2\text{KI}(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + 2\text{KCl}(\text{aq})$
52. (a) single displacement  
 (b) hydrogen gas  
 (c)  $2\text{Fe}(\text{s}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Fe}_2(\text{SO}_4)_3(\text{aq}) + 3\text{H}_2(\text{g})$
54. (a) very soluble  
 (b) very soluble  
 (c) slightly soluble
55. (a)  $\text{CdSO}_4(\text{aq}) + \text{H}_2\text{S}(\text{aq}) \rightarrow \text{CdS}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq})$   
 (b) cadmium sulfide
56. (a)  $\text{Ni}(\text{OH})_2$

57. (a)  $\text{CaCO}_3(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{CaCl}_2(\text{aq})$   
 (b) release of  $\text{CO}_2(\text{g})$
58. (a)  $\text{NH}_4\text{NO}_3(\text{s}) \rightarrow \text{N}_2\text{O}(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$   
 (b) decomposition  
 (c)  $2 \text{NH}_3(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g}) + 3 \text{H}_2\text{O}(\text{l})$   
 (d) double displacement
59. (a)  $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$   
 (b) synthesis
60. (a) synthesis reaction  
 (b) neutralization reaction
61. (a) double displacement reaction  
 (b) single displacement reaction
62. (a)  $\text{AlCl}_3(\text{aq}) + 3 \text{AgNO}_3(\text{aq}) \rightarrow 3 \text{AgCl}(\text{s}) + \text{Al}(\text{NO}_3)_3(\text{aq})$ ;  
 double displacement reaction  
 (b)  $2 \text{Li}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Li}_2\text{SO}_4(\text{aq}) + \text{H}_2(\text{g})$ ;  
 single displacement reaction  
 (c)  $\text{H}_2\text{SO}_4(\text{aq}) + 2 \text{NaOH}(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + \text{Na}_2\text{SO}_4(\text{aq})$ ;  
 neutralization reaction
63. (c)  $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2 \text{NaI}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2 \text{NaNO}_3(\text{aq})$
64. (a)  $\text{Zn}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$
66. (a) reactants:  $\text{Pb}(\text{NO}_3)_2$ , KI  
 products:  $\text{PbI}_2$ ,  $\text{KNO}_3$   
 (b)  $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2 \text{KI}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2 \text{KNO}_3(\text{aq})$
67. (a) HgO  
 (b) Hg and  $\text{O}_2$   
 (c)  $2 \text{HgO}(\text{s}) \rightarrow 2 \text{Hg}(\text{l}) + \text{O}_2(\text{g})$
68. (a)  $\text{H}_2$  and Br<sub>2</sub>  
 (b) HBr  
 (c)  $\text{Br}_2(\text{l}) + \text{H}_2(\text{g}) \rightarrow 2 \text{HBr}(\text{g})$
69. (a) no products  
 (b)  $\text{KCl}(\text{aq}) + \text{Na}(\text{s}) \rightarrow$  no reaction
72. (a)  $\text{LiCl}(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{LiNO}_3(\text{aq})$
73. (a)  $\text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2 \text{NaCl}(\text{aq})$   
 (b)  $\text{Ba}(\text{NO}_3)_2(\text{aq}) + \text{K}_2\text{CO}_3(\text{aq}) \rightarrow \text{BaCO}_3(\text{s}) + 2 \text{KNO}_3(\text{aq})$   
 (c)  $\text{MgCl}_2(\text{aq}) + 2 \text{NaOH}(\text{aq}) \rightarrow \text{Mg}(\text{OH})_2(\text{s}) + 2 \text{NaCl}(\text{aq})$   
 (d) no reaction
74. (a)  $\text{Mg}(\text{OH})_2(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + \text{MgCl}_2(\text{aq})$   
 (b) neutralization
75. (a)  $\text{SiO}_2(\text{s}) + 3 \text{C}(\text{s}) \rightarrow \text{SiC}(\text{s}) + 2 \text{CO}(\text{g})$   
 (b) double displacement
76.  $\text{HNO}_3(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{KNO}_3(\text{aq})$
77. (a) sodium hydrogen carbonate  
 (b)  $\text{NaHCO}_3(\text{s}) + \text{HF}(\text{aq}) \rightarrow \text{NaF}(\text{s}) + \text{H}_2\text{O}(\text{g}) + \text{CO}_2(\text{g})$

### 5.1 Questions, p. 197

2. (a)  $2 \text{C}_4\text{H}_{10}(\text{g}) + 13 \text{O}_2(\text{g}) \rightarrow 8 \text{CO}_2(\text{g}) + 10 \text{H}_2\text{O}(\text{g})$
3. (a)  $\text{C}_5\text{H}_{12}$  (c)  $\text{C}_6\text{H}_{14}$   
 (b)  $\text{C}_9\text{H}_{20}$
4. (a)  $2 \text{C}_6\text{H}_{14}(\text{g}) + 19 \text{O}_2(\text{g}) \rightarrow 12 \text{CO}_2(\text{g}) + 14 \text{H}_2\text{O}(\text{g})$   
 (b)  $\text{C}_6\text{H}_{14}(\text{g}) + 8 \text{O}_2(\text{g}) \rightarrow 3 \text{CO}_2(\text{g}) + 3 \text{CO}(\text{g}) + 7 \text{H}_2\text{O}(\text{g})$
11. (a) myth (d) myth  
 (b) myth (e) true  
 (c) true (f) true

### 5.3 Questions, p. 204

3. (a) basic (c) acidic  
 (b) basic (d) acidic
4. (a)  $4 \text{K}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2 \text{K}_2\text{O}(\text{s})$ ;  
 $2 \text{K}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{KOH}(\text{aq})$   
 (b)  $2 \text{Cl}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{Cl}_2\text{O}(\text{g})$ ;  
 $\text{Cl}_2\text{O}(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{HClO}(\text{aq})$   
 (c)  $\text{P}_4(\text{s}) + 5 \text{O}_2(\text{g}) \rightarrow 2 \text{P}_2\text{O}_5(\text{s})$ ;  
 $\text{P}_2\text{O}_5(\text{s}) + 3 \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{H}_3\text{PO}_4(\text{aq})$
5.  $\text{K}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{KOH}(\text{aq})$
9. (b)  $\text{CaO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}(\text{OH})_2(\text{aq})$

### 5.4 Questions, p. 211

1. (a)  $2 \text{HNO}_3(\text{aq}) + \text{Ca}(\text{OH})_2(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + \text{Ca}(\text{NO}_3)_2(\text{aq})$   
 (b)  $2 \text{HNO}_3(\text{aq}) + \text{K}_2\text{CO}_3(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + 2 \text{KNO}_3(\text{aq})$   
 (c)  $3 \text{HC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{Al}(\text{OH})_3(\text{s}) \rightarrow 3 \text{H}_2\text{O}(\text{l}) + \text{Al}(\text{C}_2\text{H}_3\text{O}_2)_3(\text{aq})$   
 (d)  $\text{H}_3\text{PO}_4(\text{aq}) + 3 \text{NaHCO}_3(\text{aq}) \rightarrow 3 \text{H}_2\text{O}(\text{l}) + 3 \text{CO}_2(\text{g}) + \text{Na}_3\text{PO}_4(\text{aq})$   
 (e)  $2 \text{H}_3\text{PO}_4(\text{aq}) + 3 \text{Ca}(\text{OH})_2(\text{aq}) \rightarrow 6 \text{H}_2\text{O}(\text{l}) + \text{Ca}_3(\text{PO}_4)_2(\text{s})$   
 (f)  $\text{H}_2\text{SO}_4(\text{aq}) + \text{Ca}(\text{HCO}_3)_2(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + 2 \text{CO}_2(\text{g}) + \text{CaSO}_4(\text{s})$   
 (g)  $2 \text{HClO}_3(\text{aq}) + \text{CaCO}_3(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + \text{Ca}(\text{ClO}_3)_2(\text{aq})$
2.  $\text{Ba}(\text{OH})_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + \text{BaSO}_4(\text{s})$ ;  
 $\text{Ba}(\text{HCO}_3)_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + 2 \text{CO}_2(\text{g}) + \text{BaSO}_4(\text{s})$
3. (a) carbonic acid  
 (b)  $2 \text{H}_2\text{CO}_3(\text{aq}) + 2 \text{NaOH}(\text{aq}) \rightarrow 3 \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + \text{Na}_2\text{CO}_3(\text{aq})$

### Chapter 5 Self-Quiz, p. 235

1. (d) 7. (a) 13. F  
 2. (b) 8. (b) 14. T  
 3. (c) 9. F 15. F  
 4. (c) 10. F 16. F  
 5. (b) 11. T 17. T  
 6. (d) 12. F 18. T

### Chapter 5 Review, p. 236

1. (c) 8. (b) 15. F  
 2. (b) 9. (c) 16. T  
 3. (a) 10. F 17. F  
 4. (b) 11. T 18. F  
 5. (c) 12. F 19. F  
 6. (a) 13. F  
 7. (d) 14. F
20. (a) iii (c) iv  
 (b) i (d) ii
21. (a) i (d) ii  
 (b) vi (e) iii  
 (c) v (f) iv
22. (a) iii (d) vi  
 (b) v (e) iv  
 (c) ii (f) i
23. carbon monoxide
26. Super Glue
27. metal
35.  $\text{C}_5\text{H}_{12}(\text{l}) + 8 \text{O}_2(\text{g}) \rightarrow 5 \text{CO}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$
39. (a)  $2 \text{Sr}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2 \text{SrO}(\text{s})$ ;  
 $\text{SrO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Sr}(\text{OH})_2(\text{aq})$   
 (b)  $\text{P}_4(\text{s}) + 3 \text{O}_2(\text{g}) \rightarrow \text{P}_4\text{O}_6(\text{s})$ ;  
 $\text{P}_4\text{O}_6(\text{s}) + 6 \text{H}_2\text{O}(\text{l}) \rightarrow 4 \text{H}_3\text{PO}_3(\text{aq})$
40.  $\text{HCl}(\text{aq})$

41. (a)  $3 \text{HNO}_3(\text{aq}) + \text{Al}(\text{OH})_3(\text{aq}) \rightarrow 3 \text{H}_2\text{O}(\text{l}) + \text{Al}(\text{NO}_3)_3(\text{aq})$   
 (b) aluminum nitrate
59. (b)  $\text{Li}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{LiOH}(\text{aq})$
60. (a)  $\text{S}_8(\text{s}) + 8 \text{O}_2(\text{g}) \rightarrow 8 \text{SO}_2(\text{g})$
61. (a) acid + hydrogen carbonate  $\rightarrow$   
 water + carbon dioxide + an ionic compound
68. (a) chemical

### Unit 2 Self-Quiz, p. 244

1. (a) 13. (b) 25. T  
 2. (d) 14. (d) 26. F  
 3. (c) 15. (a) 27. T  
 4. (d) 16. (b) 28. T  
 5. (a) 17. (a) 29. F  
 6. (c) 18. (c) 30. T  
 7. (b) 19. (b) 31. T  
 8. (b) 20. F 32. T  
 9. (a) 21. F 33. F  
 10. (c) 22. T 34. T  
 11. (a) 23. F 35. F  
 12. (c) 24. F

### Unit 2 Review, p. 246

1. (b) 10. (d) 19. F  
 2. (a) 11. (c) 20. F  
 3. (c) 12. (d) 21. T  
 4. (c) 13. (b) 22. T  
 5. (d) 14. (a) 23. T  
 6. (b) 15. F 24. F  
 7. (a) 16. F 25. F  
 8. (d) 17. T 26. T  
 9. (b) 18. T
27. (a) iii (c) i  
 (b) iv (d) ii
28. (a) i (c) ii  
 (b) iv (d) iii
40. hydrogen sulfide,  $\text{H}_2\text{S}$
46. (a) sodium hydroxide, NaOH
50. (a) hydrogen peroxide,  $\text{H}_2\text{O}_2$
53. (a) silicon, Si, and carbon dioxide,  $\text{CO}_2$   
 (b) silicon carbide, SiC, and silicon dioxide,  $\text{SiO}_2$   
 (c)  $2 \text{Si}(\text{s}) + \text{CO}_2(\text{g}) \rightarrow \text{SiC}(\text{s}) + \text{SiO}_2(\text{s})$
54. (a)  $2 \text{Al}_2\text{O}_3 + 3 \text{C} \rightarrow 4 \text{Al} + 3 \text{CO}_2$   
 (b)  $2 \text{Fe}(\text{OH})_2 + \text{H}_2\text{O}_2 \rightarrow 2 \text{Fe}(\text{OH})_3$   
 (c)  $2 \text{Ag}_2\text{O} \rightarrow 4 \text{Ag} + \text{O}_2$
56. (a)  $\text{H}_2\text{O} + \text{K}_2\text{O} \rightarrow 2 \text{KOH}$   
 (b)  $2 \text{Ca} + \text{O}_2 \rightarrow 2 \text{CaO}$   
 (c)  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
58. (a) synthesis  
 (b)  $\text{Hg}(\text{l}) + \text{Cl}_2(\text{g}) \rightarrow \text{HgCl}_2(\text{s})$
59. (a) decomposition  
 (b)  $2 \text{AgNO}_3(\text{s}) \rightarrow 2 \text{AgNO}_2(\text{s}) + \text{O}_2(\text{g})$
61. (a) single displacement  
 (b) potassium + water  $\rightarrow$   
 hydrogen + potassium hydroxide  
 (c)  $2 \text{K}(\text{s}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{KOH}(\text{aq}) + \text{H}_2(\text{g})$
63. (a) no reaction  
 (b)  $\text{Ca}(\text{s}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}(\text{OH})_2(\text{aq}) + \text{H}_2(\text{g})$   
 (c)  $2 \text{Li}(\text{s}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{LiOH}(\text{aq}) + \text{H}_2(\text{g})$   
 (d) no reaction
64. (a) double displacement  
 (b) silver chloride and nitric acid  
 (c)  $\text{AgNO}_3 + \text{HCl} \rightarrow \text{AgCl} + \text{HNO}_3$

65. (a) lead(II) carbonate  
(b)  $\text{Pb}(\text{NO}_3)_2(\text{s}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{PbCO}_3(\text{s}) + 2 \text{NaNO}_3(\text{aq})$
71. (a) basic oxide (d) basic oxide  
(b) acidic oxide (e) acidic oxide  
(c) acidic oxide (f) basic oxide
80.  $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$
81. (a)  $2 \text{LiOH} + \text{CO}_2 \rightarrow \text{Li}_2\text{CO}_3 + \text{H}_2\text{O}$
82. (a)  $\text{SO}_3(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{SO}_4(\text{aq})$   
(b) synthesis reaction
83.  $4 \text{NH}_3(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 4 \text{NO}(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$   
 $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$   
 $3 \text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{HNO}_3(\text{aq}) + \text{NO}(\text{g})$
84. (a)  $2 \text{NaN}_3(\text{s}) \rightarrow 2 \text{Na}(\text{g}) + 3 \text{N}_2(\text{g})$
86. (a) single displacement reaction  
(b) hydrogen gas,  $\text{H}_2$   
(c)  $2 \text{K}(\text{s}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{KOH}(\text{aq}) + \text{H}_2(\text{g})$
87. (a) double displacement and decomposition
90. (a) double displacement  
(b)  $\text{H}_2\text{CO}_3(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
91. (a) double displacement  
(b)  $\text{MnSO}_4(\text{aq}) + 2 \text{NH}_4\text{OH}(\text{aq}) \rightarrow (\text{NH}_4)_2\text{SO}_4(\text{aq}) + \text{Mn}(\text{OH})_2(\text{s})$
103. (a)  $4 \text{P} + 3 \text{O}_2 \rightarrow 2 \text{P}_2\text{O}_3$
- (d)  $2 \text{Na}_3\text{PO}_4 + 3 \text{CaCl}_2 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 6 \text{NaCl}$
11. (a) 52.6 %  
(b) 47.4 %
12.  $B = AC, C = \frac{B}{A}$
13. (a) exact  
(b) measurement  
(c) measurement  
(d) exact  
(e) exact  
(f) measurement
14. (a) 12.37 g  
(c) 12.37 g  
(d) -0.05 g
15. (a) 90.4 g  
(b) 2.0 g/mL  
(c) 450 atoms  
(d)  $4.7 \times 10^{-3} \text{ L}$   
(e)  $1.59 \times 10^{-25} \text{ g/u}$   
(f) 1.3 mL

## Unit 3

### Are You Ready? pp. 256–257

1. (a) (i) 2 carbon atoms, 2 hydrogen atoms  
(ii) 2 carbon atoms, 4 hydrogen atoms, 2 oxygen atoms  
(b) (i) ethyne:  $\text{C}_2\text{H}_2$   
(ii) ethanoic acid:  $\text{C}_2\text{H}_4\text{O}_2$  or  $\text{HC}_2\text{H}_3\text{O}_2$
2. (a) both are  $\text{C}_3\text{H}_6\text{O}_3$   
(b) no
4. (a) ionic  
(b) molecular  
(c) molecular  
(d) ionic  
(e) ionic  
(f) molecular
5. (a)  $2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2$   
(b)  $\text{P}_4 + 5 \text{O}_2 \rightarrow 2 \text{P}_2\text{O}_5$   
(c)  $\text{Al}_2(\text{SO}_4)_3 + 3 \text{Ca}(\text{OH})_2 \rightarrow 2 \text{Al}(\text{OH})_3 + 3 \text{CaSO}_4$   
(d)  $2 \text{C}_2\text{H}_2 + 5 \text{O}_2 \rightarrow 4 \text{CO}_2 + 2 \text{H}_2\text{O}$   
(e)  $3 \text{Fe} + \text{Al}_2(\text{SO}_4)_3 \rightarrow 3 \text{FeSO}_4 + 2 \text{Al}$   
(f)  $2 \text{H}_2\text{O}_2 \rightarrow 2 \text{H}_2\text{O} + \text{O}_2$
6. (a) NR  
(b)  $\text{Ag}(\text{s}) + \text{Mg}(\text{NO}_3)_2(\text{aq})$   
(c) NR  
(d) NR  
(e)  $\text{H}_2(\text{g}) + \text{PbCl}_2(\text{aq})$
7. (a)  $2 \text{H}_2\text{O}_2 \rightarrow 2 \text{H}_2\text{O} + \text{O}_2$   
(b) decomposition  
(c) 3.6 g  
(d) 7.2 g of water, 6.4 g of oxygen
8. (a) barium chlorate  
(b) tin(II) sulfite  
(c) iron(III) chloride  
(d) manganese(II) phosphate  
(e) lead(II) nitrate  
(f) tetraphosphorus decoxide
9. (a)  $\text{Cu}(\text{NO}_3)_2$  (d)  $\text{Fe}(\text{ClO}_3)_3$   
(b)  $\text{CCl}_4$  (e)  $\text{Ca}(\text{HCO}_3)_2$   
(c) CO
10. (a)  $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$   
(b)  $\text{Pb}(\text{NO}_3)_2 + 2 \text{KI} \rightarrow \text{PbI}_2 + 2 \text{KNO}_3$   
(c)  $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2 \text{NaCl}$

### 6.1 Practice Questions, p. 263

1. (a) quantitative (d) qualitative  
(b) quantitative (e) qualitative  
(c) qualitative (f) quantitative
2. (a) mass and age

### 6.3 Questions, p. 270

5. (a) 48  
(b)  $2.4 \times 10^{22}$  molecules  $\text{CO}_2$
6. (a)  $2.00 \times 10^{-2}$   
(b)  $2 \times 10^{22}$   
(c)  $6.7 \times 10^{-4}$
7.  $7.9 \times 10^{-8} \text{ mol}$

### 6.4 Questions, p. 277

4. (a) 159.70 g/mol (d) 206.98 g/mol  
(b) 100.09 g/mol (e) 96.11 g/mol  
(c) 114.26 g/mol
5. 0.0901 mol
6.  $4.12 \times 10^{-4} \text{ mol}$
7.  $2.20 \times 10^{-2} \text{ g}$
8.  $2.1 \times 10^{-4} \text{ mol}$
9. (a) 63 000 kg  
(b)  $6.4 \times 10^5 \text{ mol}$
10. 9.00 g
11. 58 g/mol
12. 23.0 g

### 6.5 Questions, p. 283

1. (a)  $1.2 \times 10^{24}$   
 $5.3 \times 10^{19}$
2. (a) 0.500 mol  
(b)  $1.00 \times 10^2 \text{ mol}$   
(c) 0.420 mol
3. (a)  $4.2 \times 10^{24}$  atoms C,  $8.4 \times 10^{24}$  atoms O  
(b) 310 g
4.  $9.704 \times 10^{23}$  formula units
5. (a)  $1.388 \times 10^{-3} \text{ mol}$   
(b)  $6.68 \times 10^{21}$  atoms
6. (a)  $4.92 \times 10^{22}$  atoms  
(b)  $1.41 \times 10^{29}$  atoms
7. (a)  $4.3 \times 10^{19}$  formula units  
(b)  $1.3 \times 10^{20}$  oxide ions
8. (a)  $6.3 \times 10^{-3} \text{ mol}$   
(b)  $3.8 \times 10^{21} \text{ FPO}_3^{2-}$  ions;  
 $7.6 \times 10^{21} \text{ Na}^+$  ions
9. (a)  $2.84 \times 10^{24}$  atoms Ag;  
 $1.8 \times 10^{22}$  atoms Au

### 6.6 Questions, p. 288

1. 40.0 % Ca, 12 % C, 48.0 % O  
2. 52.2 % C; 34.6 % O; 13 % H  
4. (a) 0.80 g H  
(b) 92.0 % C, 8.0 % H  
5. (a)  $\text{C}_3\text{H}_4$   
(b) same percentage  
(c)  $\text{C}_2\text{H}_4$
7. (a) 3.09 % H, 65.31 % O, 31.60 % P  
(b) 79.85 % Cu, 20.15 % S  
(c) 69.94 % Fe, 30.06 % O  
(d) 17.48 % B, 77.62 % O, 4.90 % H

### 6.7 Questions, p. 293

2.  $\text{H}_2\text{CO}_3$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$ ,  $\text{C}_3\text{H}_6\text{O}_3\text{N}$
3. (a) same,  $\text{NO}_2$   
(b) not the same  
(c) same, CH  
(d) same,  $\text{C}_6\text{H}_5\text{O}$
4. (a) 2,  $\text{C}_2\text{H}_2$   
(b) 3,  $\text{C}_2\text{H}_2\text{O}_3$   
(c) 2,  $\text{Na}_2\text{S}_2\text{O}_3$   
(d) 3,  $\text{C}_4\text{H}_{11}\text{O}_3$
5.  $\text{C}_3\text{H}_4\text{O}_3$
6. compound 1: NO; compound 2:  $\text{NO}_2$
7.  $\text{C}_6\text{H}_{11}\text{ON}$
8.  $\text{Al}_4\text{C}_3$
9. HgO
10. (a) 74.2 % X  
(b) Na, sodium

### 6.9 Questions, p. 300

2. (a)  $\text{N}_2\text{O}_4$   
(b)  $\text{C}_6\text{H}_{12}$   
(c)  $\text{C}_6\text{H}_5\text{O}_9$   
(d)  $\text{C}_2\text{F}_2\text{Br}_2\text{O}_2$
6. empirical formula:  $\text{C}_4\text{N}_2\text{H}_5\text{O}$ ;  
molecular formula:  $\text{C}_8\text{N}_4\text{H}_{10}\text{O}_2$
7. (a)  $\text{C}_{20}\text{H}_{38}\text{O}_2$
8. empirical formula:  $\text{CH}_2\text{O}$ ;  
molecular formula:  $\text{C}_6\text{H}_{12}\text{O}_6$

### Chapter 6 Self-Quiz, p. 307

1. (b) 8. (c) 15. T  
2. (a) 9. (d) 16. F  
3. (b) 10. T 17. F  
4. (c) 11. T 18. F  
5. (c) 12. F 19. T  
6. (d) 13. F 20. T  
7. (d) 14. T

### Chapter 6 Review, p. 308

1. (a) 4. (b) 7. (a)  
2. (b) 5. (c) 8. (b)  
3. (d) 6. (c) 9. (a)  
10. (a) ii, iv (c) i  
(b) i, iii, iv  
11. F 14. T 17. F  
12. T 15. F 18. T  
13. T 16. F 19. F  
20. (a) qualitative analysis  
(b) quantitative analysis  
21. (a) quantitative analysis  
(b) qualitative analysis  
22. (b)  $9.28 \times 10^{-23} \text{ g}$   
23. (b)  $1.1 \times 10^{19}$   
24.  $1.50 \times 10^{-2}$   
27. 26.98 g/mol  
28. (a) 16.00 u  
(b) 32.00 g/mol  
(c) 48.00 g/mol

29. (b) 237.95 g/mol  
 31. (a) 158.04 g/mol  
     (b) 1.63 mol  
 32. 150 g  
 33. 0.84 kg  
 34.  $4.1 \times 10^{23}$  Si atoms  
 35. (a)  $8.4 \times 10^{23}$  molecules  
     (b)  $6.7 \times 10^{24}$  atoms  
 36. 0.253 mol  
 38. 75.0 %  
 39. 25.53 % Mg, 74.47 % Cl  
 41. 38.7 % K, 13.8 % N, 47.5 % O  
 42. (a) 22.4 g Br  
     (b) 10.1 % Al, 89.9 % Br  
 43. 5.93 % H, 94.1 % S  
 46. KI  
 47. (a) 25.8 % O  
     (b) Na<sub>2</sub>O  
 48. POCl<sub>3</sub>  
 49. N<sub>2</sub>O<sub>4</sub>  
 50. PCl<sub>5</sub>  
 53. (a) quantitative (d) qualitative  
     (b) quantitative (e) quantitative  
     (c) qualitative  
 54.  $4.98 \times 10^{-11}$  mol  
 55.  $1.5 \times 10^{18}$  km  
 59. MgSO<sub>4</sub>·7 H<sub>2</sub>O and MgSO<sub>4</sub>·5 H<sub>2</sub>O  
 60. (a) 275 g  
     (b) 0.662 mol  
 61. (a) 20.2 mol  
     (b) 669 g  
 62.  $3.76 \times 10^{24}$  atoms  
 63. (a)  $7.22 \times 10^{22}$  atoms  
     (b)  $6.54 \times 10^{22}$  atoms  
 64. (a)  $3.9 \times 10^{22}$  SO<sub>3</sub> molecules  
     (b)  $1.09 \times 10^{25}$  atoms  
 65. 46.5 % Fe  
 66. 52.1 % C, 13.2 % H, 34.7 % O  
 68. 69.9 % Fe, 30.1 % O  
 69. 40.0 % Ca, 12.0 % C, 48.0 % O  
 70. 56.3 % P, 43.7 % S  
 71. (a) CO<sub>2</sub> and CH<sub>4</sub>  
     (b) C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> and H<sub>2</sub>O<sub>2</sub>  
 73. (a) 56.9 % S  
     (b) MgS  
 74. CaCl<sub>2</sub>  
 75. (a) 53.3 % O  
     (b) CH<sub>2</sub>O  
 76. (a) 71.1 % O  
     (b) HCO<sub>2</sub>  
     (c) H<sub>2</sub>C<sub>2</sub>O<sub>4</sub>  
 77. P<sub>4</sub>O<sub>10</sub>  
 79. (b) 90 mol N (c) 182 kg H

### 7.1 Questions, p. 320

3. 2:3  
 6. (a) 2 mol NH<sub>3</sub>, 2.5 mol O<sub>2</sub>  
     (b) 1.2 mol NH<sub>3</sub>, 1.5 mol O<sub>2</sub>  
     (c)  $5.2 \times 10^{-3}$  mol NH<sub>3</sub>,  
      $6.5 \times 10^{-3}$  mol O<sub>2</sub>  
 8. (b) 2 molecules N<sub>2</sub>, 6 molecules H<sub>2</sub>  
 9. (a) 0.75 mol Mg<sub>3</sub>N<sub>2</sub>  
     (b) 4.5 mol H<sub>2</sub>O  
     (c) 0.042 mol Mg<sub>3</sub>N<sub>2</sub>; 0.13 mol Mg(OH)<sub>2</sub>;  
     0.083 mol NH<sub>3</sub>

### 7.2 Questions, p. 325

3. 2.0 mol and 1.5 mol; 0.60 mol and  
 0.45 mol; 108 g and 96 g

4. (a) 20 %  
 5. (a) 0.757 g CaO  
     (b) 0.243 g H<sub>2</sub>O  
 6. (a) single displacement  
     (b) 5400 g I<sub>2</sub>  
 7. (a)  $4 \text{ Fe(s)} + 3 \text{ O}_2\text{(g)} \rightarrow 2 \text{ Fe}_2\text{O}_3\text{(s)}$   
     (b) 20 mol Fe; 10 mol Fe<sub>2</sub>O<sub>3</sub>  
     (c) 3.22 g Fe  
     (d) 4.60 g  
 8. (a) 2.20 g CO<sub>2</sub>  
 9. (a)  $\text{NH}_4\text{NO}_3\text{(s)} \rightarrow \text{N}_2\text{O(g)} + 2 \text{ H}_2\text{O(g)}$   
     (b) decomposition  
     (c) 0.550 g N<sub>2</sub>O  
 10. 1050 kg HNO<sub>3</sub>

### 7.3 Questions, p. 330

2. (a) limiting: H<sub>2</sub>; excess: N<sub>2</sub>  
     (b) 6 NH<sub>3</sub> molecules  
     (c) 1 molecule N<sub>2</sub> excess  
 3. (a)  $\text{Mg(s)} + 2 \text{ HCl(aq)} \rightarrow$   
     H<sub>2</sub>(g) + MgCl<sub>2</sub>(aq)  
     (b) single displacement  
 7. (a) limiting: H<sub>2</sub>; excess: Au<sub>2</sub>S<sub>3</sub>

### 7.4 Questions, p. 335

3. (a) limiting: Mg; excess: N<sub>2</sub>  
     (b) limiting: Ca; excess: AlCl<sub>3</sub>  
     (c) limiting: FeS<sub>2</sub>; excess: O<sub>2</sub>  
 4. (a) 0.48 mol Ag  
     (b) 0.040 mol AgNO<sub>3</sub> excess  
 5. (a) 0.35 mol AlCl<sub>3</sub>  
     (b) 0.15 mol HCl excess  
 6. 450 g SO<sub>3</sub>  
 7. (a)  $\text{H}_2\text{(g)} + \text{Cl}_2\text{(g)} \rightarrow 2 \text{ HCl(g)}$   
     (b) 329 g HCl  
 8. 0.73 g AlCl<sub>3</sub>  
 9. 25.4 g CO<sub>2</sub>  
 10. (a) Cl<sub>2</sub>  
     (b) 40.1 g TiCl<sub>4</sub>  
 11. 10 g HCN

### 7.5 Questions, p. 339

6. (a)  $\text{Zn(s)} + 2 \text{ AgNO}_3\text{(aq)} \rightarrow$   
     2 Ag(s) + Zn(NO<sub>3</sub>)<sub>2</sub>(aq)  
     (b) 9.9 g Ag  
     (c) 73 %  
 7. (a) 130 g Cl<sub>2</sub>  
     (b) 220 g NaCl  
 8. 87.2 %  
 9. (a) 13 g (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>  
     (b) 79 %  
 10. 59.2 %  
 11. (a)  $\text{N}_2\text{(g)} + 3 \text{ H}_2\text{(g)} \rightarrow 2 \text{ NH}_3\text{(g)}$   
     (b) 298 g NH<sub>3</sub>  
     (c) 26.9 mol N<sub>2</sub>  
     (d) 755 g N<sub>2</sub>  
 12. 1.4 kg CO  
 13. 125 g S  
 14. (a) 51.6 g P<sub>4</sub>O<sub>10</sub>  
     (b) 67.8 g H<sub>3</sub>PO<sub>4</sub>

### Chapter 7 Self-Quiz, p. 345

1. (c) 8. T 15. F  
 2. (b) 9. F 16. T  
 3. (b) 10. T 17. F  
 4. (a) 11. F 18. T  
 5. (c) 12. T 19. F  
 6. (d) 13. F 20. T  
 7. (b) 14. F

### Chapter 7 Review, p. 346

1. (d) 11. F  
 2. (a) 12. F  
 3. (c) 13. T  
 4. (a) 14. F  
 5. (b) 15. T  
 6. (a) 16. F  
 7. (b) 17. T  
 8. (d) 18. F  
 9. (d) 19. F  
 10. (c)  
 20. (a) ii (c) iii  
     (b) iv (d) i  
 21. (a) 3:1  
     (b) 1:1  
     (c) 3:2  
 22. (a) 0.6 mol Cu  
     (b) 0.2 mol CuO  
 23. nitrogen, N<sub>2</sub>(g)  
 24. antacid tablet  
 25. yellow-orange  
 38. (a) 0.25; 1.0  
     (b) 0.800; 0.400  
 39. (a) 85.3 mol O<sub>2</sub>  
     (b) 13 mol H<sub>2</sub>O  
 41. (a)  $2 \text{ C}_8\text{H}_{18}\text{(l)} + 25 \text{ O}_2\text{(g)} \rightarrow$   
     16 CO<sub>2</sub>(g) + 18 H<sub>2</sub>O(g)  
     (b) 22 kg CO<sub>2</sub>  
 42. (a) 1:2  
     (b) 1:4  
 44. (a)  $2 \text{ Cu(s)} + \text{O}_2\text{(g)} \rightarrow 2 \text{ CuO(s)}$   
     (b) 7.0 mol of copper(II) oxide; 0.5 mol of  
     excess  
 45. (a) 14.4 g C; 21.6 g H<sub>2</sub>O  
     (b) 54.0 g C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>  
 46.  $1.00 \times 10^2$  g Hg; 8.00 g O<sub>2</sub>  
 50. (a) 0.903 g Ag  
     (b) 9.03 %  
 51. (a)  $\text{CH}_4\text{(g)} + 2 \text{ O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} + 2 \text{ H}_2\text{O(g)}$   
     (b)  $1.5 \times 10^8$  tonnes  
 55. (a)  $\text{Zn(s)} + 2 \text{ HCl(aq)} \rightarrow \text{ZnCl}_2\text{(aq)} + \text{H}_2\text{(g)}$   
 57. (a) 13.0 g AsH<sub>3</sub>  
     (b) 3.32 g As<sub>2</sub>O<sub>3</sub>  
 58. (a)  $\text{Fe(s)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{FeSO}_4\text{(aq)} + \text{H}_2\text{(g)}$   
     (b) 1.45 g H<sub>2</sub>  
     (c) 29.8 g H<sub>2</sub>SO<sub>4</sub>  
 59. (a) 5600 kg NO  
     (b) 1300 kg NH<sub>3</sub>  
 60. 31.4 g PH<sub>3</sub>  
 61. 3.94 kg NaAu(CN)<sub>2</sub>  
 62. (a) 29.5 g C<sub>6</sub>H<sub>5</sub>CH<sub>3</sub>  
     (b) 74.6 %  
 63. (a) 17 g  
     (b) 13 g C<sub>7</sub>H<sub>6</sub>O<sub>3</sub>

### Unit 3 Self-Quiz, p. 354

1. (a) 13. (c) 25. F  
 2. (d) 14. (d) 26. T  
 3. (a) 15. (d) 27. T  
 4. (b) 16. (d) 28. F  
 5. (b) 17. T 29. T  
 6. (b) 18. F 30. F  
 7. (d) 19. F 31. T  
 8. (d) 20. T 32. T  
 9. (b) 21. T 33. F  
 10. (a) 22. F 34. F  
 11. (d) 23. F 35. F  
 12. (c) 24. T

**Unit 3 Review, p. 356**

- (c)      12. (b)      23. F
- (b)      13. (a)      24. F
- (c)      14. (d)      25. T
- (a)      15. (b)      26. F
- (b)      16. (a)      27. T
- (a)      17. F      28. T
- (a)      18. F      29. F
- (b)      19. F      30. F
- (b)      20. F      31. F
- (d)      21. F
- (b)      22. F
- 7 mol;  $4 \times 10^{24}$  molecules
- $1.3 \times 10^{-1}$  mol
- 0.250 mol and 39.9 g Fe<sub>2</sub>O<sub>3</sub>
- (a)  $2.0 \times 10^6$  g  
(b) 4.3 %  
(c)  $\$4.3 \times 10^9$
- $2.33 \times 10^{-23}$  g/atom
- 74.10 g/mol
- 22.6 g Ti
- 0.0642 mol Zn
- $2.23 \times 10^{23}$  atoms Al
- (a)  $6.02 \times 10^{23}$  molecules  
(b)  $4.82 \times 10^{24}$  atoms
- $1.5 \times 10^{21}$  atoms
- $5.7 \times 10^{19}$  molecules HNO<sub>3</sub>
- 37 g H; 63 g O<sub>2</sub>
- 77.5 % KNO<sub>3</sub>; 22.5 % KCl
- 69.94 % Fe; 30.06 % O
- 17.27 % N
- 6.73 % H
- 50 g tin; 80 g antimony; 370 g lead
- Al<sub>2</sub>S<sub>3</sub>
- empirical formula CH<sub>3</sub>; molecular formula C<sub>2</sub>H<sub>6</sub>
- 581 g
- 2 mol H<sub>2</sub>O; 1 mol O<sub>2</sub>
- 10 mol NH<sub>3</sub>
- 3.50 mol NO
- 23.8 g F<sub>2</sub>
- Na
- Fe
- ethylene oxide
- 20 molecules CO<sub>2</sub>
- (a) CH  
(b) (i) C = 92.3 %, H = 7.76 %  
(ii) C = 92.3 %, H = 7.76 %  
(iii) C = 92.3 %, H = 7.76 %  
(c) (i) 13.0 g/mol  
(ii) 26 g/mol  
(iii) 78 g/mol  
(d) all correspond to diagram A
- C<sub>8</sub>H<sub>16</sub>O<sub>4</sub>
- $8.05 \times 10^{21}$  atoms

**Unit 4****Are You Ready? pp. 366–367**

- relative density
- (a) ionic  
(b) greater than the melting point of ice
- (a) between molecules: London forces, dipole-dipole attractions and hydrogen bonding between ions: ionic bonding  
(b) London forces, dipole-dipole attractions, hydrogen bonding, ionic bonds  
(c) H<sub>2</sub>, H<sub>2</sub>S, H<sub>2</sub>O
- (b) same result

- (a)  $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2 \text{NaI}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2 \text{NaNO}_3(\text{aq})$   
(b) PbI<sub>2</sub>  
(c) 29.97 g NaI
- (a) potassium sulfide  
(b) aluminum hydroxide  
(c) nitrogen dioxide  
(d) diphosphorus pentoxide  
(e) lead(II) sulfite
- (a) KNO<sub>2</sub>  
(b) Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>  
(c) Ca(HCO<sub>3</sub>)<sub>2</sub>  
(d) MnSO<sub>4</sub> · 7H<sub>2</sub>O  
(e) SO<sub>3</sub>
- 74.10 g/mol
- (a) 10  
(b) basic  
(c) Ca(OH)<sub>2</sub>
- (a)  $\text{Ba}(\text{OH})_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2 \text{H}_2\text{O}(\text{l})$

**8.1 Questions, p. 375**

- surface tension

**8.2 Questions, p. 381**

- (a) solution  
(b) pure substance  
(c) heterogeneous mixture  
(d) heterogeneous mixture  
(e) pure substance  
(f) solution  
(g) solution  
(h) solution  
(i) solution  
(j) solution

**8.3 Tutorial 1 Practice, p. 384**

- (a)  $\text{CaCl}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2 \text{Cl}^{-}(\text{aq})$   
(b)  $\text{NH}_4\text{NO}_2(\text{s}) \rightarrow \text{NH}_4^{+}(\text{aq}) + \text{NO}_2^{-}(\text{aq})$   
(c)  $\text{Fe}(\text{OH})_3(\text{s}) \rightarrow \text{Fe}^{3+}(\text{aq}) + 3 \text{OH}^{-}(\text{aq})$   
(d)  $\text{Al}_2(\text{SO}_4)_3(\text{s}) \rightarrow 2 \text{Al}^{3+}(\text{aq}) + 3 \text{SO}_4^{2-}(\text{aq})$

**8.3 Questions, p. 389**

- (a) non-polar
- (a)  $\text{Ca}(\text{NO}_3)_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq})$   
(b)  $\text{KClO}_4(\text{s}) \rightarrow \text{K}^{+}(\text{aq}) + \text{ClO}_4^{-}(\text{aq})$   
(c)  $(\text{NH}_4)_2\text{CO}_3(\text{s}) \rightarrow 2 \text{NH}_4^{+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq})$   
(d)  $\text{Fe}_2(\text{SO}_4)_3(\text{s}) \rightarrow 2 \text{Fe}^{3+}(\text{aq}) + 3 \text{SO}_4^{2-}(\text{aq})$

**8.5 Questions, p. 397**

- (a) 30 g  
(b) least soluble: KClO<sub>3</sub>; most soluble: NH<sub>4</sub>Cl  
(c) KNO<sub>3</sub>  
(d) 50 g  
(e) 24 °C

**8.6 Questions, p. 402**

- 0.400 mol/L
- 170 g
- 730 mL
- $2.50 \times 10^3$  mL
- 22 g
- 11 g

**8.7 Questions, p. 405**

- (a) 25 mL, 50 mL, and 75 mL  
(b) same amount of solute

**8.8 Questions, p. 411**

- $1.0 \times 10$  g Cl<sub>2</sub>
- 430 g H<sub>2</sub>O
- 1.0 L 2-propanol
- (a) 18% W/V  
(b) 1.0 mol/L

- (a) 30.08 ppm  
(b) 33.2 L
- $2.5 \times 10^{-2}$  ppb
- (a) 4.2 g NaHCO<sub>3</sub>  
(b) 0.050 mol NaHCO<sub>3</sub>  
(c) 8.4 % W/V NaHCO<sub>3</sub>  
(d) 84 000 ppm  
(e) 1.0 mol/L
- (a)  $3.671 \times 10^{20}$  kg  
(b)  $4.4 \times 10^9$  kg Au

**Self-Quiz, p. 415**

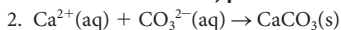
- (c)      8. (c)      15. T
- (a)      9. (b)      16. T
- (b)      10. (b)      17. F
- (c)      11. T      18. F
- (a)      12. F      19. T
- (b)      13. F      20. F
- (a)      14. F      21. T

**Chapter 8 Review, pp. 416–421**

- (a)      7. (c)      13. T
- (b)      8. (b)      14. F
- (d)      9. (d)      15. F
- (d)      10. F      16. T
- (c)      11. F      17. F
- (a)      12. F      18. T
- (a) v      (d) iv  
(b) ii      (e) iii  
(c) i
- (a) iii      (d) i  
(b) vi      (e) iv  
(c) v      (f) ii
- concentrated solution
- (a)  $c = \frac{n}{V}$   
(b)  $V = \frac{n}{c}$   
(c)  $n = cV$
- (a)  $c_c = \frac{c_d V_d}{V_c}$   
(b)  $V_c = \frac{c_d V_d}{c_c}$   
(c)  $c_d = \frac{c_c V_c}{V_d}$   
(d)  $V_d = \frac{c_c V_c}{c_d}$
- (a)  $1.00 \times 10^9$  g  
(b)  $1.00 \times 10^6$  L
- (a) heterogeneous (c) homogeneous  
(b) homogeneous (d) homogeneous
- (a) concentrated  
(b) dilute  
(c) dilute
- (a)  $\text{KCl}(\text{s}) \rightarrow \text{K}^{+}(\text{aq}) + \text{Cl}^{-}(\text{aq})$   
(b)  $\text{MgBr}_2(\text{s}) \rightarrow \text{Mg}^{2+}(\text{aq}) + 2 \text{Br}^{-}(\text{aq})$   
(c)  $\text{Li}_2\text{SO}_4(\text{s}) \rightarrow 2 \text{Li}^{+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
- 0.16 mol/L
- 1.7 mol/L
- 1.0 mol/L
- 1340 g
- (a)  $c = \frac{n}{V}$   
(b)  $V = \frac{n}{c}$   
(c)  $c_d = \frac{c_c V_c}{V_d}$

63. 0.647 mol/L  
 66. (a)  $2.9 \times 10^5$  ppb  
 (b)  $0.9 \times 10^8$  ppt  
 73. 3 L  
 74. (a) 20 %

### 9.1 Tutorial 1 Practice, p. 427



### 9.1 Questions, p. 428

2. (a)  $2 \text{AgNO}_3(\text{aq}) + \text{Sn}(\text{s}) \rightarrow 2 \text{Ag}(\text{s}) + \text{Sn}(\text{NO}_3)_2(\text{aq})$   
 (b)  $2 \text{Ag}^+(\text{aq}) + \text{Sn}(\text{s}) \rightarrow 2 \text{Ag}(\text{s}) + \text{Sn}^{2+}(\text{aq})$   
 (c) potassium carbonate  
 (d)  $\text{Sn}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{SnCO}_3(\text{s})$   
 3. (a) Product with lowest solubility: FeS  
 Spectator ions:  $\text{Na}^+(\text{aq})$ ,  $\text{Br}^-(\text{aq})$   
 Net ionic equation:  
 $\text{Fe}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{FeS}(\text{s})$   
 (b) Product with lowest solubility:  $\text{BaCO}_3$   
 Spectator ions:  $\text{NH}_4^+(\text{aq})$ ,  $\text{OH}^-(\text{aq})$   
 Net ionic equation:  
 $\text{Ba}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{BaCO}_3(\text{s})$   
 5.  $\text{Cl}_2(\text{g}) + 2 \text{I}^-(\text{aq}) \rightarrow \text{I}_2(\text{s}) + 2 \text{Cl}^-(\text{aq})$   
 6. (a) NaOH, KOH  
 (b)  $\text{Fe}^{3+}(\text{aq}) + 3 \text{OH}^-(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$   
 7.  $2 \text{Cl}^-(\text{aq}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow \text{Cl}_2(\text{g}) + \text{H}_2(\text{g}) + 2 \text{OH}^-(\text{aq})$   
 8. (b)  $3 \text{Ca}^{2+}(\text{aq}) + 2 \text{PO}_4^{3-}(\text{aq}) \rightarrow \text{Ca}_3(\text{PO}_4)_2(\text{s})$   
 9. (a)  $2 \text{Al}(\text{s}) + 3 \text{CuCl}_2(\text{aq}) \rightarrow 3 \text{Cu}(\text{s}) + 2 \text{AlCl}_3(\text{aq})$   
 10. (a)  $\text{Ca}^{2+}(\text{aq}) + \text{C}_2\text{O}_4^{2-}(\text{aq}) \rightarrow \text{CaC}_2\text{O}_4(\text{s})$

### 9.2 Questions, p. 436

5.  $3 \times 10^{-3}$  g  
 8. (a)  $\text{Ca}^{2+}(\text{aq}) + \text{CO}_3^{2-} \rightarrow \text{CaCO}_3(\text{s})$

### 9.3 Questions, p. 441

1. (a) qualitative (d) quantitative  
 (b) quantitative (e) quantitative  
 (c) qualitative  
 5. (a) yellow-green (c) green  
 (b) whitish green (d) yellow

### 9.5 Questions, p. 449

1. (a) 0.13 mol/L  
 (b) 7.5 g/L  
 2. (a)  $\text{NiSO}_4(\text{aq}) + 2 \text{NaOH}(\text{aq}) \rightarrow \text{Ni}(\text{OH})_2(\text{s}) + \text{Na}_2\text{SO}_4(\text{aq})$   
 (b) 1.16 g  
 3. (a) 0.759 mol/L  
 (b) 0.304 L  
 4. 0.701 L  
 5. (a)  $2 \text{Al}(\text{s}) + 3 \text{CuSO}_4(\text{aq}) \rightarrow 3 \text{Cu}(\text{s}) + \text{Al}_2(\text{SO}_4)_3(\text{aq})$   
 (b) 0.270 g  
 6.  $1.9 \times 10^{12}$  L  
 7.  $\text{CaCl}_2$   
 8. (a)  $\text{Na}^+$ : 1.0 mol/L  
 (b)  $\text{NH}_4^+$ : 0.4 mol/L  
 (c)  $\text{Fe}^{3+}$ : 3.0 mol/L  
 9. 9.0 g

### Chapter 9 Self-Quiz, p. 455

1. (b) 7. (a) 13. F  
 2. (d) 8. (b) 14. T  
 3. (c) 9. (c) 15. F  
 4. (c) 10. F 16. F  
 5. (b) 11. F 17. T  
 6. (d) 12. F 18. T

### Chapter 9 Review, p. 456

1. (b) 7. (b) 13. T  
 2. (b) 8. (a) 14. F  
 3. (c) 9. (c) 15. T  
 4. (b) 10. F 16. F  
 5. (a) 11. T 17. F  
 6. (a) 12. F 18. T  
 19. (a) vi (d) i  
 (b) iii (e) iv  
 (c) ii (f) v  
 22. single-displacement and double-displacement  
 23. double-displacement  
 24. physical contaminants  
 30. (a) qualitative analysis  
 (b) quantitative analysis  
 36. 3:1  
 38. (a)  $2 \text{Na}^+(\text{aq}) + 2 \text{I}^-(\text{aq}) + \text{Pb}^{2+}(\text{aq}) + 2 \text{ClO}_3^-(\text{aq}) \rightarrow 2 \text{Na}^+(\text{aq}) + \text{PbI}_2(\text{s}) + 2 \text{ClO}_3^-(\text{aq})$   
 40. (a) very soluble (e) very soluble  
 (b) very soluble (f) slightly soluble  
 (c) very soluble (g) very soluble  
 (d) slightly soluble (h) very soluble  
 42. cations  $\text{NH}_4^+$ ,  $\text{K}^+$ , and  $\text{Na}^+$ , anion:  $\text{NO}_3^-$   
 44. (a) heterogeneous mixture  
 (b) homogeneous mixture  
 (c) homogeneous mixture  
 45. (a) collection  
 (b) coagulation, flocculation, and sedimentation  
 (c) filtration  
 (d) softening  
 49. chlorination and filtration  
 50. (a)  $2 \text{NaOH}(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + \text{Na}_2\text{SO}_4(\text{aq})$   
 52. (a)  $(\text{NH}_4)_2\text{SO}_4(\text{s}) \rightarrow 2 \text{NH}_4^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$   
 (b) 2:1  
 53. (a)  $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$   
 54. (a)  $\text{Fe}(\text{s}) + \text{Cu}(\text{NO}_3)_2(\text{aq}) \rightarrow \text{Cu}(\text{s}) + \text{Fe}(\text{NO}_3)_2(\text{aq})$   
 (b)  $\text{Fe}(\text{s}) + \text{Cu}^{2+}(\text{aq}) + 2 \text{NO}_3^-(\text{aq}) \rightarrow \text{Cu}(\text{s}) + \text{Fe}^{2+}(\text{aq}) + 2 \text{NO}_3^-(\text{aq})$   
 (c)  $\text{Fe}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Cu}(\text{s}) + \text{Fe}^{2+}(\text{aq})$

### 10.1 Tutorial 1 Practice, p. 468

1. (a) hydrobromic acid  
 (b) phosphorus acid  
 (c) hydrosulfurous acid  
 (d) sulfurous acid  
 (e) periodic acid  
 (f) hypofluorous acid  
 2. (a) HF(aq)  
 (b)  $\text{H}_2\text{SO}_3(\text{aq})$   
 (c) HClO(aq)  
 (d)  $\text{HBrO}_4(\text{aq})$

### 10.1 Questions, p. 469

2. (a)  $\text{HC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{NaHCO}_3(\text{s}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{NaC}_2\text{H}_3\text{O}_2(\text{aq})$   
 3. (a) Ag: no; Zn: yes; Al: yes  
 (b)  $\text{H}_2\text{SO}_4(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{H}_2(\text{g}) + \text{ZnSO}_4(\text{aq})$   
 $3 \text{H}_2\text{SO}_4(\text{aq}) + 2 \text{Al}(\text{s}) \rightarrow 3 \text{H}_2(\text{g}) + \text{Al}_2(\text{SO}_4)_3(\text{aq})$   
 4. (a) carbonic acid  
 (b) hydroiodic acid  
 (c) hydrosulfuric acid  
 (d) phosphoric acid  
 (e) nitric acid

- (f) hydrofluoric acid  
 (g) nitrous acid  
 (h) sulfurous acid  
 (i) phosphorus acid  
 (j) periodic acid  
 (k) hypochlorous acid  
 6. (a) HBr(aq) (c)  $\text{HClO}_2(\text{aq})$   
 (b)  $\text{HClO}_4(\text{aq})$  (d) HI(aq)  
 7. (a) magnesium hydroxide  
 (b) potassium hydroxide

### 10.2 Questions, p. 475

8. (a) 100 times  
 10. (a)  $10^3$  times (c)  $10^7$  times  
 (b)  $10^4$  times (d)  $10^7$  times  
 11. (a)  $10^4$  times (c)  $10^2$  times  
 (b)  $10^3$  times (d)  $10^5$  times  
 12. (b)  $\text{H}_2\text{SO}_4(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + \text{BaSO}_4(\text{s})$

### 10.3 Questions, p. 485

3. (a) 1.00 mol/L  
 8. (b) 50 mL  
 (c) methyl red  
 9. (a)  $\text{CaCO}_3(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) + \text{CaCl}_2(\text{aq})$   
 (b) 0.63 g  
 10. (a)  $2 \text{NH}_4\text{OH}(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + (\text{NH}_4)_2\text{SO}_4(\text{aq})$   
 (b) 8.54 mL  
 (c) 0.43 mol/L  
 11. 0.0160 mol/L  
 12. (a)  $\text{KH}(\text{IO}_3)_2(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + 2 \text{KIO}_3(\text{aq})$   
 (b) 0.151 mol/L  
 13. 0.598 mol/L

### Chapter 10 Self-Quiz, p. 491

1. (b) 7. (c) 13. F  
 2. (c) 8. (a) 14. T  
 3. (d) 9. (b) 15. F  
 4. (a) 10. T 16. F  
 5. (b) 11. F 17. T  
 6. (c) 12. F 18. T

### Chapter 10 Review, pp. 492–496

1. (d) 7. (b) 13. F  
 2. (c) 8. (a) 14. T  
 3. (b) 9. (a) 15. F  
 4. (b) 10. F 16. T  
 5. (d) 11. F 17. F  
 6. (c) 12. T 18. T  
 19. (a) i (d) iv  
 (b) iii (e) ii  
 (c) v  
 24. (a) carbon dioxide gas  
 (b) hydrogen gas  
 39. (a) hydrobromic acid (c) nitric acid  
 (b) phosphorous acid (d) perchloric acid  
 40. (a) barium hydroxide  
 (b) lithium hydroxide  
 (c) strontium hydroxide  
 (d) beryllium hydroxide  
 41. (a)  $\text{H}_3\text{PO}_4(\text{aq})$  (c)  $\text{H}_2\text{S}(\text{aq})$   
 (b)  $\text{HNO}_2(\text{aq})$  (d)  $\text{H}_2\text{Te}(\text{aq})$   
 42. (a)  $\text{Ca}(\text{OH})_2(\text{aq})$  (c) NaOH(aq)  
 (b)  $\text{NH}_4\text{OH}(\text{aq})$  (d)  $\text{Al}(\text{OH})_3(\text{aq})$   
 43. (a) NR  
 (b)  $\text{Mg}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$   
 (c)  $2 \text{K}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow 2 \text{KCl}(\text{aq}) + \text{H}_2(\text{g})$   
 (d) NR



- (e)  $\text{Ca(s)} + 2 \text{HCl(aq)} \rightarrow \text{CaCl}_2\text{(aq)} + \text{H}_2\text{(g)}$   
 (f)  $2 \text{Al(s)} + 6 \text{HCl(aq)} \rightarrow 2 \text{AlCl}_3\text{(aq)} + 3 \text{H}_2\text{(g)}$
45. carbonic acid is  $\text{H}_2\text{CO}_3\text{(aq)}$ ; phosphoric acid is  $\text{H}_3\text{PO}_4\text{(aq)}$
46. (b)  $\text{NaHCO}_3\text{(s)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2\text{(g)}$   
 $\text{Mg(OH)}_2\text{(s)} + 2 \text{HCl(aq)} \rightarrow 2 \text{MgCl}_2\text{(aq)} + 2 \text{H}_2\text{O(l)}$   
 $\text{CaCO}_3\text{(s)} + 2 \text{HCl(aq)} \rightarrow \text{CaCl}_2\text{(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2\text{(g)}$
50. 0.093 mol/L
51. (b) 16.31 mL  
 (c)  $\text{H}_2\text{SO}_4\text{(aq)} + 2 \text{KOH(aq)} \rightarrow \text{K}_2\text{SO}_4\text{(aq)} + 2 \text{H}_2\text{O(l)}$   
 (d) 0.054 mol/L
52. (a) 26.02 mL  
 (b)  $1.3 \times 10^{-3}$  mol  
 (c) 0.14 mol/L HCl
53. (a) base  
 (b) potassium hydroxide, KOH  
 (c) provide an electric current
55. (a)  $2 \text{NO}_2\text{(g)} + \text{H}_2\text{O(l)} \rightarrow \text{HNO}_2\text{(aq)} + \text{HNO}_3\text{(aq)}$   
 (b)  $\text{SO}_2\text{(g)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{SO}_3\text{(aq)}$   
 (c)  $\text{SO}_3\text{(g)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{SO}_4\text{(aq)}$
61. (a) basic

#### Unit 4 Self-Quiz, pp. 500–501

1. (b) 13. (a) 25. T  
 2. (d) 14. (b) 26. F  
 3. (a) 15. (d) 27. F  
 4. (b) 16. (c) 28. F  
 5. (c) 17. (b) 29. T  
 6. (a) 18. (a) 30. T  
 7. (d) 19. T 31. T  
 8. (b) 20. F 32. F  
 9. (b) 21. F 33. F  
 10. (c) 22. F 34. T  
 11. (d) 23. F 35. T  
 12. (c) 24. T 36. F

#### Unit 4 Review, pp. 502–509

1. (c) 9. (c) 17. T  
 2. (b) 10. (d) 18. F  
 3. (a) 11. (b) 19. T  
 4. (c) 12. (a) 20. T  
 5. (a) 13. F 21. F  
 6. (c) 14. T 22. F  
 7. (a) 15. F 23. F  
 8. (d) 16. F 24. T
25. (a) i (e) ii  
 (b) ii (f) iii  
 (c) i (g) i  
 (d) ii
26. (a) iv (d) vi  
 (b) i (e) ii  
 (c) v (f) iii
27. hydrogen bonding  
 28. ethanol  
 30. a gas  
 32. nitrate,  $\text{NO}_3^-$   
 33. silver ions  
 34. total ionic equation  
 35. a net ionic equation  
 36.  $\text{SO}_4^{2-}\text{(aq)}$   
 38. “potable” means “safe to drink”  
 40. reagent B  
 42. acids are colourless and bases are pink  
 43. (a) carbonic acid

- (b) hydrofluoric acid  
 (c) phosphoric acid  
 (d) hydrosulfuric acid  
 (e) perchloric acid
44. (a)  $\text{H}_3\text{PO}_3\text{(aq)}$  (d)  $\text{HClO}_2\text{(aq)}$   
 (b)  $\text{HCl(aq)}$  (e)  $\text{HClO}_3\text{(aq)}$   
 (c)  $\text{HI(aq)}$
47.  $\text{H}^+\text{(aq)} + \text{OH}^-\text{(aq)} \rightarrow \text{H}_2\text{O(l)}$
54. heterogeneous
60. (a)  $2 \text{Al(s)} + 6 \text{HCl(aq)} \rightarrow 2 \text{AlCl}_3\text{(aq)} + 3 \text{H}_2\text{(g)}$   
 (b) Al  
 (c)  $2 \text{Al(s)} + 6 \text{H}^+\text{(aq)} + 6 \text{Cl}^-\text{(aq)} \rightarrow 2 \text{Al}^{3+}\text{(aq)} + 6 \text{Cl}^-\text{(aq)} + 3 \text{H}_2\text{(g)}$   
 (d)  $\text{Cl}^-\text{(aq)}$   
 (e)  $2 \text{Al(s)} + 6 \text{H}^+\text{(aq)} \rightarrow 2 \text{Al}^{3+}\text{(aq)} + 3 \text{H}_2\text{(g)}$
65. (a) 2.00 mol/L  
 (b) 4.00 mol/L  
 (c) 6.00 mol/L
67.  $\text{CaO(s)} + 2 \text{HCl(aq)} \rightarrow \text{CaCl}_2\text{(aq)} + \text{H}_2\text{O(l)}$
68. (a) iron(II) chloride,  $\text{FeCl}_2\text{(aq)}$ , and hydrogen sulfide,  $\text{H}_2\text{S(g)}$   
 (b)  $\text{FeS(s)} + 2 \text{HCl(aq)} \rightarrow \text{FeCl}_2\text{(aq)} + \text{H}_2\text{S(g)}$
69. (a) basic solution
70. (a)  $\text{HA(aq)}$   
 (b)  $\text{HA} \rightarrow \text{H}^+\text{(aq)} + \text{A}^-\text{(aq)}$   
 (c)  $\text{HNO}_3\text{(aq)} \rightarrow \text{H}^+\text{(aq)} + \text{NO}_3^-\text{(aq)}$
71. (a) ionic compound and water  
 (b)  $\text{H}_2\text{SO}_4\text{(aq)} + 2 \text{KOH(aq)} \rightarrow 2 \text{H}_2\text{O(l)} + \text{K}_2\text{SO}_4\text{(aq)}$   
 (c)  $2 \text{H}^+\text{(aq)} + \text{SO}_4^{2-}\text{(aq)} + 2 \text{K}^+\text{(aq)} + 2 \text{OH}^-\text{(aq)} \rightarrow 2 \text{H}_2\text{O(l)} + \text{SO}_4^{2-}\text{(aq)} + 2 \text{K}^+\text{(aq)}$   
 (d)  $2 \text{H}^+\text{(aq)} + 2 \text{OH}^-\text{(aq)} \rightarrow 2 \text{H}_2\text{O(l)}$
75. (a)  $\text{Li}_2\text{S(aq)} \rightarrow 2 \text{Li(aq)}^+ + \text{NO}_3^-\text{(aq)}$   
 (b)  $\text{MgCl}_2\text{(aq)} \rightarrow \text{Mg}^{2+}\text{(aq)} + 2 \text{Cl}^-\text{(aq)}$   
 (c)  $\text{Al}_2\text{(SO}_4)_3\text{(aq)} \rightarrow 2 \text{Al}^{3+}\text{(aq)} + 3 \text{SO}_4^{2-}\text{(aq)}$
78. 3.42 L  
 79. 0.294 mol/L
86. (a)  $\text{Na}_2\text{CO}_3\text{(aq)} + \text{CaCl}_2\text{(aq)} \rightarrow \text{CaCO}_3\text{(s)} + 2 \text{NaCl(aq)}$   
 (b) 0.04 mol  
 (c) 1:1  
 (d) 0.04 mol  
 (e) 0.16 L
88. (a)  $2 \text{FeCl}_3\text{(aq)} + 3 \text{H}_2\text{S(aq)} \rightarrow 6 \text{HCl(aq)} + \text{Fe}_2\text{S}_3\text{(s)}$   
 (b) 0.55 mol of  $\text{FeCl}_3$ , 1.10 mol of  $\text{H}_2\text{S}$   
 (c) 3:2  
 (d) 2:1  
 (e)  $\text{FeCl}_3$   
 (f) 57 g
90. (a) the pH 2 solution  
 (b) 1000 times  
 (c) pH 2
91. (a)  $\text{HCl(aq)} \rightarrow \text{H}^+\text{(aq)} + \text{Cl}^-\text{(aq)}$   
 (b) 1.0 mol/L  
 (c) 0.001 mol/L
93. (a) 0.01540 L  
 (b)  $\text{H}_2\text{SO}_4\text{(aq)} + 2 \text{KOH(aq)} \rightarrow \text{K}_2\text{SO}_4\text{(aq)} + 2 \text{H}_2\text{O(l)}$   
 (c) 0.00308 mol  
 (d)  $1.54 \times 10^{-3}$  mol  
 (e)  $1.54 \times 10^{-1}$  mol/L
94. 0.178 mol/L  
 101. (b)  $\text{H}_2\text{SO}_3\text{(aq)}$

## Unit 5

### Are You Ready? pp. 512–513

- solid
- gas
- gas
- $\text{cm}^3$ , L, mL
- (b)  $-70^\circ\text{C}$
- (a) direct relationship  
(b) inverse relationship
- (a) most: gas A; least: gas C  
(b) (i) gas A, 87 mL; gas B, 66 mL; gas C, 36 mL  
(ii) gas A, 58 mL; gas B, 49 mL; gas C, 30 mL
- (a) Alberta and Ontario; 50 mt  
(c) Alberta
- balloons 1 and 2 rise; balloon 3 falls
- (a)  $2 \text{SO}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2 \text{SO}_3\text{(g)}$   
 (b)  $\text{SO}_3\text{(g)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{SO}_4\text{(aq)}$   
 (c) 64.07 g/mol  
 (d)  $1.6 \times 10^4$  mol  $\text{SO}_2\text{(g)}$   
 (e)  $1.6 \times 10^4$  mol  $\text{SO}_3\text{(g)}$   
 (f)  $1.6 \times 10^4$  mol  $\text{H}_2\text{SO}_4\text{(aq)}$   
 (g) 1.5 t  $\text{H}_2\text{SO}_4$
- (a)  $B = \frac{DEC}{FA}$  (c)  $F = \frac{DEC}{AB}$   
 (b)  $D = \frac{ABF}{CE}$

### 11.4 Questions, p. 533

- (a) volatile organic compounds
- (a) air quality health index
- (a)  $\text{O}_3$ : max noon, min midnight;  $\text{NO}_2$ : max midnight, min noon

### 11.7 Questions, p. 546

- (a) 440 mm Hg (c) 980 mm Hg  
(b) 16.7 kPa (d) 130 kPa

### 11.8 Questions, p. 553

- (a)  $1427^\circ\text{C}$  (c) 5 K  
(b) 2600 K (d)  $-219^\circ\text{C}$
- 0.15 L
- 0.277 L
- 0.016 L
- 0.12 L

### 11.9 Questions, p. 562

- $9.0 \times 10$  L
- $3.0 \times 10^2$  kPa
- (a) 42.2 kPa (c) 610 mL  
(b) 240 mL
- $4.4 \times 10^2$  kPa
- $8.1 \times 10^2$  C
- 89.2 kPa
- 241 kPa
- (a) decrease  
(b)  $2.2 \times 10^2$  kPa
- $1.6 \times 10^3$   $\text{cm}^3$
- $2.07 \times 10^4$  kPa
- 5.8 mL
- 15.4 L
- $49^\circ\text{C}$

### Chapter 11 Self-Quiz, p. 567

- (a) 8. (c) 15. T
- (b) 9. (b) 16. F
- (d) 10. F 17. T
- (c) 11. F 18. F
- (a) 12. F
- (b) 13. F
- (a) 14. T

