(d) Assign the following element identities:

X = Li

Y = Na

Z = Mg

$2\ Li_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + 2\ LiOH_{(aq)}$

$2\ Li_{(s)} + 2\ HCl_{(aq)} \rightarrow H_{2(g)} + 2\ LiCl_{(aq)}$

$2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + 2\ NaOH_{(aq)}$

$2\ Na_{(s)} + 2\ HCl_{(aq)} \rightarrow H_{2(g)} + 2\ NaCl_{(aq)}$

$Mg_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + Mg(OH)_{2(s)}$

$Mg_{(s)} + 2\ HCl_{(aq)} \rightarrow H_{2(g)} + MgCl_{2(aq)}$

(e) All reactions are single displacement reactions.

With respect to the reaction with water:

Use a lighted splint to ignite the gas produced. A "pop" sound when ignited indicates hydrogen gas. The aqueous solution could be tested with pH paper to determine if it is basic. These tests would indicate that the reaction was a single displacement type, with the metal displacing hydrogen in the water ($H_2O_{(l)}$) to produce hydrogen gas and a metal hydroxide.

With respect to the reaction with acid:

Use a lighted splint to ignite the gas produced. A "pop" sound when ignited indicates hydrogen gas. The aqueous solution could be evaporated and the remaining compound analyzed to determine if it is a metal chloride. These tests would indicate that the reaction was a single displacement type, with the metal displacing hydrogen in the acid ($HCl_{(aq)}$) to produce hydrogen gas and a metal chloride.

### Making Connections

4. (a) $2K_{(s)} + BeCl_{2(s)} \xrightarrow{Pt} Be_{(s)} + 2\ KCl_{(l)}$ single displacement

   (b) Beryllium chloride should be stored dry within air and water vapour tight sealed containers. The substance should only be handled in environmentally enclosed and controlled areas, and all required protective equipment such as gas masks, protective clothing, and protective gloves should be worn.

5. (a) $C_{(s)} + SiO_{2(l)} \rightarrow Si_{(l)} + CO_{2(g)}$ single displacement

   $Si_{(s)} + 2\ Cl_{2(g)} \rightarrow SiCl_{4(l)}$ synthesis

   $2\ Mg_{(s)} + SiCl_{4(l)} \rightarrow Si_{(s)} + 2\ MgCl_{2(aq)}$ single displacement

   (b) Emissions of carbon dioxide gas (a product of the first reaction) cause rain to become slightly acidic. Carbon dioxide gas also contributes to the greenhouse effect, which may lead to global warming and dramatic climate changes.

## CHAPTER 3 REVIEW

**(Page 146)**

### Understanding Concepts

1. The kinetic molecular theory states that all matter is made up of particles in continuous random motion.

   A gas has widely separated molecules in constant, chaotic motion. The average kinetic energy of the molecules is much larger than the energy associated with the attractive forces between them.

   With liquids, the attractive forces between molecules have energies comparable to the kinetic energies of the molecules. The attractive forces are able to hold the molecules close to each other. However, the attractive forces are not strong enough to hold the molecules rigidly in place. In fact, molecules within a liquid are able to move in a more or less chaotic fashion, allowing liquids to be poured, and to flow to take the shape of their container.

   With solids, the intermolecular attractions are sufficiently strong enough to hold the molecules rigidly in place. The average kinetic energy of the molecules is much smaller than the energy associated with the attractive forces between them. The particles of a solid are not free to move. However, the molecules within a solid may undergo vibrational motion.

2. The collision–reaction theory suggests that particles must collide with the correct orientation and at sufficient speed to react. Chemical reactions will not occur when the collision orientation is not correct, and/or when the speed of collision is not sufficient.
3. (a) $S_8 + 8\ O_2 \rightarrow 8\ SO_2$ synthesis (combustion)
   (b) $HBr + NaOH \rightarrow NaBr + H_2O$ double displacement
   (c) $N_2 + 3\ H_2 \rightarrow 2\ NH_3$ synthesis
   (d) $PtCl_4 \rightarrow Pt + 2\ Cl$ decomposition
   (e) $2\ MgO + Si \rightarrow 2\ Mg + SiO_2$ single displacement
   (f) $Na_2S + 2\ HCl \rightarrow 2\ NaCl + H_2S$ double displacement
   (g) $P_4 + 5\ O_2 \rightarrow P_4\ O_{10}$ synthesis (combustion)
   (h) $Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$ single displacement
4. (a) potassium chlorate → potassium chloride + oxygen
   $2\ KClO_{3(s)} \rightarrow 2\ KCl_{(s)} + 3\ O_{2(g)}$ (decomposition)
   (b) sodium + water (HOH) → hydrogen + sodium hydroxide
   $2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + 2\ NaOH$ (single displacement)
   (c) carbon + oxygen → carbon dioxide
   $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ (combustion)
   (d) zinc + sulfuric acid → zinc sulfate + hydrogen
   $Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$ (single displacement)
   (e) silver nitrate + potassium iodide → silver iodide + potassium nitrate
   $AgNO_{3(aq)} + KI_{(aq)} \rightarrow AgI_{(s)} + KNO_{3(aq)}$ (double displacement)
   (f) sodium sulfate + barium chloride → barium sulfate + sodium chloride
   $Na_2SO_{4(aq)} + BaCl_{2(aq)} \rightarrow BaSO_{4(s)} + 2\ NaCl_{(aq)}$ (double displacement)
   (g) iron + oxygen → iron(III) oxide
   $4\ Fe_{(s)} + 3\ O_{2(g)} \rightarrow 2\ Fe_2O_{3(s)}$ (combustion/synthesis)
   (h) sulfur trioxide + water → sulfuric acid
   $SO_{3(g)} + H_2O_{(g)} \rightarrow H_2SO_{4(aq)}$ (synthesis)
5. (c) calcium sulfate; (h) silver iodide; (i) copper(I) chloride; (j) lead(II) sulfate are all of low solubility
6. $Na_2SO_{4(aq)} + Ca(NO_3)_{2(aq)} \rightarrow 2\ NaNO_{3(aq)} + CaSO_{4(s)}$
   $KI_{(aq)} + AgNO_{3(aq)} \rightarrow KNO_{3(aq)} + AgI_{(s)}$
   $NaCl_{(aq)} + CuNO_{3(aq)} \rightarrow NaNO_{3(aq)} + CuCl_{(s)}$
   $Na_2SO_{4(aq)} + Pb(NO_3)_{2(aq)} \rightarrow 2\ NaNO_{3(aq)} + PbSO_{4(s)}$
7. By referring to the relevant activity series. A metal will be displaced by a metal above it in the series; a nonmetal will be similarly displaced by a nonmetal.
8. (a) $2\ Li_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + 2\ LiOH_{(aq)}$
   (b) $2\ K_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + 2\ KOH_{(aq)}$
   (c) $Cu_{(s)} + 2\ AgNO_{3(aq)} \rightarrow 2\ Ag_{(s)} + Cu(NO_3)_{2(aq)}$
   (d) $Fe_{(s)} + NaCl_{(aq)} \rightarrow NR$
   (e) $Mg_{(s)} + Ca(NO_3)_{2(aq)} \rightarrow NR$
   (f) $2\ Al_{(s)} + 6\ HCl_{(aq)} \rightarrow 3\ H_{2(g)} + 2\ AlCl_{3(aq)}$
   (g) $Pb_{(s)} + Cu(NO_3)_{2(aq)} \rightarrow Cu_{(s)} + Pb(NO_3)_{2(aq)}$
   (h) $F_{2(g)} + 2\ HCl_{(aq)} \rightarrow Cl_{2(g)} + 2\ HF_{(aq)}$
   (i) $I_{2(s)} + NaBr_{(aq)} \rightarrow NR$
9. (a) single displacement
   (b) solid iodine and potassium chloride

(c) $Cl_{2(g)} + 2\ KI_{(aq)} \rightarrow I_{2(s)} + 2\ KCl_{(aq)}$

(d) Chlorine, being more electronegative, displaces the iodide ion.

10. (a) Assume their elemental states: fluorine, bromine, nitrogen. Nitrogen gas is unreactive; fluorine is more reactive than bromine as it has a higher electronegativity.

(b) rubidium, potassium, magnesium. Rubidium is less electronegative than potassium, which is more reactive than magnesium.

### Applying Inquiry Skills

11. (a) $2\ Li_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + 2\ LiOH_{(aq)}$

Reasons:

- Group 1 metals are soft and silvery
- water is colourless
- the gas test indicates hydrogen
- the litmus test indicates one of the products is a base
- the flame test (bright red) indicates that lithium could be a constituent of one of the products

(b) Reasonably sure. We don't know if the metal floated when it was put in the liquid (lithium would). If we assume the liquid was pure water, the metal in the reaction could be strontium (flame test).

$Sr_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + Sr(OH)_{2(aq)}$

To be sure that the metal wasn't strontium, another sample of the metal could be observed when it is put in water. If it floats (as lithium would), it can't be strontium (density 2.6 g/cm$^3$). A chemical test would involve adding sulfuric acid to the product solution. Strontium sulfate has low solubility, but lithium sulfate has high solubility. If sulfuric acid were added to the solution, and strontium ions were present, strontium sulfate should precipitate in a double displacement reaction:

$Sr(OH)_{2(aq)} + H_2SO_{4(aq)} \rightarrow 2\ H_2O_{(l)} + SrSO_{4(aq)}$

It is also possible the liquid was water, but containing one or more solutes, for example, an acid. A test with pH paper or litmus paper would test for this kind of solute.

12. part 1: step 1, $Ni(OH)_{2(s)}$ should form and be filtered

step 2, adding the barium chloride should result in the precipitation of $BaSO_{4(s)}$

$NiSO_{4(aq)} + 2\ NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + Ni(OH)_{2(s)}$

$Na_2SO_{4(aq)} + BaCl_{2(aq)} \rightarrow 2\ NaCl_{(aq)} + BaSO_{4(s)}$

both are double displacement reactions

part 2: step 5, the mass of the crucible and contents should increase due to the synthesis of $MgO_{(s)}$ as the magnesium combusts

$2\ Mg + O_2 \rightarrow 2\ MgO_{(s)}$

part 3: step 6, small bubbles may form on the zinc as the zinc slowly replaces hydrogen in water in a single displacement reaction; after the addition of sulfuric acid, gas should be generated more vigorously in another single displacement reaction. The small amount of zinc hydroxide produced in the first reaction should also react with the sulfuric acid in a double displacement reaction.

step 7, the gas will pop, indicating hydrogen

$Zn_{(s)} + 2\ H_2O_{(l)} \rightarrow H_{2(g)} + Zn(OH)_{2(s)}$

$Zn + H_2SO_{4(aq)} \rightarrow H_{2(g)} + ZnSO_{4(aq)}$

$Zn(OH)_{2(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + 2\ H_2O_{(l)}$

$2\ H_{2(g)} + O_{2(g)} \rightarrow 2\ H_2O_{(g)}$

### Making Connections

13. Barium sulfate is a low-solubility solid. Because it does not dissolve, no barium ions are freed into solution within the patient and so there are no toxic effects.

14. Students are to investigate the refining process for a major industrial element, including any chemical reactions.

GO TO www.science.nelson.com, Chemistry 11, Teacher Centre.

15. Students are to research the composition and design of safety matches and produce a poster.

GO TO www.science.nelson.com, Chemistry 11, Teacher Centre.

# UNIT 1 REVIEW

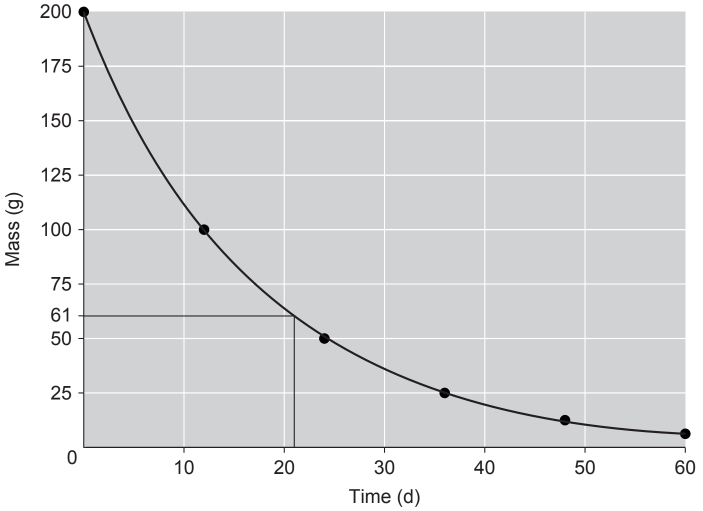
**(Page 150)**

## Understanding Concepts

1. (a) iodine-127: p = 53; e = 53; n = 74 (127 − 53)
   (b) phosphorus-32: p = 15; e = 15; n = 17 (32 − 15)
   (c) Cu-64 (copper-64): p = 29; e = 29; n = 35 (64 − 29)
   (d) Hg-203 (mercury-203): p = 80; e = 80; n = 123 (203 − 80)
2. Comparison of Radiation

| | mass | speed | charge |
|---|---|---|---|
| **alpha particles** | 4u | relatively low | 2+ |
| **beta particles** | very small | high | 1- |
| **gamma rays** | none (for now) | speed of light | 0 |

3.




4. (a) Bromine and fluorine each have seven electrons in their outer shell.
   (b) After the removal of the first electron, the nuclear charge has not been reduced, but the number of electrons has been. The pull of the nucleus on the remaining valence electron should be stronger. As a result it will take more energy to remove the second electron.
   (c) In order to achieve a full octet (full outer shell of electrons), oxygen must gain two electrons, producing the $O^{2-}$ ion.
   (d) Argon has a full outer shell of electrons, which is a very stable arrangement.
   (e) Fluorine requires one electron to reach a stable octet and it has few electrons shielding the charge of the nucleus. As a result it has a high electron affinity.
5. The phenomenon of radioactivity indicated that atoms could change, i.e., that Dalton's model of an indivisible, ball-like atom was flawed. That radiation often consisted of charged particles (alpha and beta) indicated that the atom had positive and negative components.
6. (a) mercury; transition metal
   (b) halogen
   (c) alkali metal
   (d) alkaline earth metal
   (e) halogen
   (f) noble gas