# 5.2 BALANCING CHEMICAL EQUATIONS

## PRACTICE

**(Page 211)**

### Understanding Concepts

1. Conservation of mass requires that a reaction equation somehow represent the fact that total reactant mass equals total product mass.
2. (a) $Mg_{(s)} + 2\ HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

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

   (c) $CaCO_{3(s)} + 2\ HCl_{(aq)} \rightarrow CaCl_{2(s)} + H_2O_{(l)} + CO_{2(g)}$

   (d) $Cu_{(s)} + 4\ HNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2\ NO_{(g)} + 2\ H_2O_{(l)}$

   (e) $2\ C_3H_{6(g)} + 9\ O_{2(g)} \rightarrow 6\ CO_{2(g)} + 6\ H_2O_{(g)}$
3. (a) $2\ H_{2(g)} + O_{2(g)} \rightarrow 2\ H_2O_{(g)}$

   (b) Correct

   (c) $Pb_{(s)} + 2\ AgNO_{3(aq)} \rightarrow 2\ Ag_{(s)} + Pb(NO_3)_{2(aq)}$

   (d) Correct
4. $Fe(NO_3)_{3(aq)}\ 1\ 3\ LiOH_{(aq)} \rightarrow 3\ LiNO_{3(aq)}\ 1\ Fe(OH)_{3(s)}$

## PRACTICE

**(Page 213)**

### Understanding Concepts

5. The formula coefficients of a chemical equation represent the mole ratio of substances in the reaction.
6. Consider: $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$
   This reaction equation shows clearly that the number of moles of substances in reactions is not conserved: two moles of reactants become one mole of product.
7. $3\ NO_{2(g)} + H_2O_{(l)} \rightarrow 2\ HNO_{3(aq)} + NO_{(g)}$

   The mole ratio is 3:1:2:1 for the reaction equation as written here.
8. In a chemical industry, the amounts produced and consumed in reactions determine the economics of the process — so the mole ratio is essential knowledge for determining whether any process is practical.

## PRACTICE

**(Page 214)**

### Understanding Concepts

9. Fertilizers increase crop production. Without them there would not be enough food produced to support the current population of the Earth.
10. Fertilizer excess that enters the environment can cause serious changes in watersheds, affecting all living things that depend on that water supply.

### Making Connections

11. Typical reports might select groups like Ducks Unlimited, Canada, which is dedicated to actively working to preserve Canada's wetlands. DU emphasize that not only do wetlands provide habitat for a complex ecosystem of living things; they act as natural filters for our water supply.

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## Explore an Issue Role Play: Controlling the Use of Fertilizers

**(Page 215)**

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## SECTION 5.2 QUESTIONS

**(Page 215)**

### Understanding Concepts

1. Balancing by inspection uses a trial-and-error approach to determining the coefficients of a reaction equation.
2. (a) $2\ Al_{(s)} + 3\ CuCl_{2(aq)} \rightarrow 3\ Cu_{(s)} + 2\ AlCl_{3(aq)}$

   (b) $Cu_{(s)} + 2\ HCl_{(aq)} \rightarrow H_{2(g)} + CuCl_{2(aq)}$

   (c) $2\ HgO_{(s)} \rightarrow 2\ Hg_{(l)} + O_{2(g)}$

   (d) $CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3\ H_{2(g)}$ (step i)

   $CO_{(g)} + 2\ H_{2(g)} \rightarrow CH_3OH_{(g)}$ (step ii)
3. (a) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

   (b) $S_{8(s)} + 8\ O_{2(g)} \rightarrow 8\ SO_{2(g)}$

   (c) $Cu(OH)_{2(s)} + H_2SO_{4(aq)} \rightarrow 2\ H_2O_{(l)} + CuSO_{4(aq)}$

   (d) $CaSiO_{3(s)} + H_2SO_{3(aq)} \rightarrow H_2SiO_{3(aq)} + CaSO_{3(s)}$

   (e) $CaCO_{3(s)} + 2\ HNO_3 \rightarrow H_2CO_{3(aq)} + Ca(NO_3)_{2(aq)}$

   (f) $2\ Al_{(s)} + 3\ H_2SO_{4(aq)} \rightarrow 3\ H_{2(g)} + Al_2(SO_4)_{3(aq)}$

   (g) $SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$

   (h) $2\ Fe_{(s)} + 3\ H_2SO_{3(aq)} \rightarrow 3\ H_{2(g)} + Fe_2(SO_3)_{3(s)}$

   (i) $N_{2(g)} + O_{2(g)} \rightarrow 2\ NO_{(g)}$

   (j) $CO_{2(g)} + H_2O_{(l)} \rightarrow H_2CO_{3(aq)}$

   (k) $CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(g)}$

   (l) $2\ C_4H_{10(g)} + 13\ O_{2(g)} \rightarrow 8\ CO_{2(g)} + 10\ H_2O_{(g)}$

   (m) $2\ FeS_{(s)} + 3\ O_{2(g)} \rightarrow 2\ FeO_{(s)} + 2\ SO_{2(g)}$

   (n) $2\ H_2S_{(g)} + 3\ O_{2(g)} \rightarrow 2\ H_2O_{(g)} + 2\ SO_{2(g)}$

   (o) $2\ CaCO_{3(s)} + 2\ SO_{2(g)} + O_{2(g)} \rightarrow 2\ CaSO_{4(s)} + 2\ CO_{2(g)}$
4. (a) $4\ CH_3NO_{2(l)} + 7\ O_{2(g)} \rightarrow 4\ CO_{2(g)} + 6\ H_2O_{(g)} + 4\ NO_{2(g)}$

   The mole ratio is 4:7:4:6:4 for the reaction equation as written here.

   (b) $2\ Al_{(s)} + 3\ CuCl_{2(aq)} \rightarrow 3\ Cu_{(s)} + 2\ AlCl_{3(aq)}$

   The mole ratio is 2:3:3:2 for the reaction equation as written here.

### Making Connections

5. Fertilizers are sold with information about what area can be treated per kilogram. Farmers would have to do area calculations, cost calculations, and predictive calculations about the value of projected increased crop yield.