A chemical reaction is a process in which one or more substances, the reactants, are transformed into one or more different substances, the products.

A chemical equation describes what happens in a chemical reaction. The equation shows the reactants on the left hand side, the products on the right hand side, and the chemical formulas of the substances.

X and Y are the reactants. XY is the product.

The chemical formula of methane is CH₄.

The chemical formula of carbon dioxide is CO₂.

One atom of carbon and two atoms of oxygen in a molecule of carbon dioxide (CO₂).

One atom of carbon and four atoms of hydrogen in a molecule of methane (CH₄).

The reactants (CH₄ and CO₂) have four atoms of hydrogen. The products (CO₂ and 2H₂O) have four (2x2) atoms of hydrogen. The number of hydrogen atoms are the same.
### p104

9 \( C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O \)

- \( C = 12 \)
- \( H = 22 \)
- \( O = 35 \)

Balanced equation

10 \( CO_2 + 2H_2O \rightarrow 3O_2 + C_6H_{12}O_{6} \)

- \( C = 1 \)
- \( O = 4 \)
- \( H = 4 \)

Not balanced for C, O or H

11 \( Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O \)

- \( Ca = 1 \)
- \( O = 4 \)
- \( H = 4 \)

Balanced equation

12 \( 4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O \)

- \( N = 4 \)
- \( O = 6 \)

Balanced equation

13 \( K_2CO_3 + BaCl_2 \rightarrow KCl + BaCO_3 \)

- \( K = 2 \)
- \( C = 1 \)
- \( O = 6 \)

Balanced equation

14 \( Fe_2O_3 + 3C \rightarrow 3CO + 2Fe \)

- \( Fe = 2 \)
- \( C = 3 \)

Balanced equation

15 \( H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O \)

- \( H = 4 \)
- \( S = 1 \)
- \( Na = 2 \)

Balanced equation

16 \( Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + 2H_2O \)

- \( Mg = 1 \)
- \( O = 6 \)
- \( S = 1 \)

Balanced equation

### p105

1 \( 2Cu + O_2 \rightarrow 2CuO \)
2 \( 2H_2 + O_2 \rightarrow 2H_2O \)
3 \( 2H_2O \rightarrow 2H_2 + O_2 \)
4 \( 8Fe + S_8 \rightarrow 8FeS \)
5 \( 2Fe + 3Cl_2 \rightarrow 2FeCl_3 \)
6 \( 2NaCl \rightarrow 2Na + Cl_2 \)
7 \( 3Ca + N_2 \rightarrow Ca_3N_2 \)
8 \( H_2 + Br_2 \rightarrow 2HBr \)
9 \( 4Al + 3O_2 \rightarrow 2Al_2O_3 \)
10 \( Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O \)
11 \( 2AgNO_3 + Cu \rightarrow Cu(NO_3)_2 + 2Ag \)
12 \( 4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O \)
13 \( Fe_2O_3 + 3C \rightarrow 3CO + 2Fe \)
14 \( Fe_2O_3 + CO \rightarrow 3CO_2 + 2Fe \)
15 \( CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \)
16 \( 2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O \)

### p107

1 A combination reaction occurs when two or more substances combine chemically to produce one product. \( X + Y \rightarrow XY \) is a combination reaction.

2 X and Y are the reactants. XY is the product.

3 a) and e) are the combination reactions (producing one product).

4 I would expect glucose to be broken down to carbon and water: \( C_6H_{12}O_6 \rightarrow C + H_2O \)

### p109

1 A decomposition reaction occurs when a compound is chemically broken down into simpler substances. \( XY \rightarrow X + Y \) is a decomposition reaction.

2 XY is the reactant. X and Y are the products.

3 a) and d) are the decomposition reactions (a compound broken down into simpler substances).

4 I would expect glucose to be broken down to carbon and water: \( C_6H_{12}O_6 \rightarrow C + H_2O \)
**p111**

1 A single replacement reaction occurs when an element in a compound is replaced by another element.
   
   \[ XY + Z \rightarrow XZ + Y \] is a single replacement reaction.

2 \( XY \) and \( Z \) are the reactants. \( XZ \) and \( Y \) are the products.

3 \( a) \) and \( c) \) are single replacement reactions.

4 \( \text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow 2\text{Fe} + \text{Al}_2\text{O}_3 \) The Al replaces the Fe in the \( \text{Fe}_2\text{O}_3 \). A single replacement.

**p113**

1 A double replacement reaction occurs when two compounds swap elements to produce two new compounds.

   \[ AB + CD \rightarrow AD + CB \] is a double replacement reaction.

2 \( AB \) and \( CD \) are the reactants. \( AD \) and \( CB \) are the products.

3 \( a) \) and \( c) \) are double replacement reactions.

4 \( 2\text{HCl} + \text{Ca(OH)}_2 \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} \) (a) \( 2\text{HNO}_3 + \text{Mg(OH)}_2 \rightarrow \text{Mg(NO}_3\text{)}_2 + 2\text{H}_2\text{O} \) (b) \( \text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} \) (c)

**p115**

1 Reactions that produce energy are called **exothermic** reactions. The burning of fossil fuels such as coal, oil, and gas produce heat. These are **exothermic** reactions. A reaction that produces heat, **exothermic**, will warm the surroundings.

2 Reactions that absorb energy are called **endothermic** reactions. Many decomposition reactions absorb heat in breaking the compound into smaller compounds. These are **endothermic** reactions. A reaction that absorbs heat, **endothermic**, will cool the surroundings.

3 \( a) \) The temperature in an exothermic reaction increases.

4 \( b) \) The temperature in an endothermic reaction decreases.

**p116**

1 \( 2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO} \) (b) \( \text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2 \) (c) \( 2\text{C}_2\text{H}_4 + 5\text{O}_2 \rightarrow 4\text{CO}_2 + 2\text{H}_2\text{O} \)

2 \( \text{Mg} = 2 \) \( \text{Mg} = 2 \) \( \text{Ca} = 1 \) \( \text{Ca} = 1 \) \( \text{C} = 4 \) \( \text{C} = 4 \)

3 \( \text{O} = 2 \) \( \text{O} = 2 \) \( \text{C} = 1 \) \( \text{C} = 1 \) \( \text{H} = 4 \) \( \text{H} = 4 \)

4 \( \text{Mass is conserved} \) \( \text{Mass is conserved} \)

**p117**

1 The number of atoms in the reactants is equal to the number of atoms in the products.

2 \( 2\text{Zn} + \text{O}_2 \rightarrow 2\text{ZnO} \) (b) \( 2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2 \) (c) \( \text{SnO}_2 + 2\text{H}_2 \rightarrow \text{Sn} + 2\text{H}_2\text{O} \)

3 \( \text{Zn} = 2 \) \( \text{Zn} = 2 \) \( \text{H} = 4 \) \( \text{H} = 4 \) \( \text{Sn} = 1 \) \( \text{Sn} = 1 \)

4 \( \text{O} = 2 \) \( \text{O} = 2 \) \( \text{O} = 4 \) \( \text{O} = 4 \) \( \text{O} = 2 \) \( \text{O} = 2 \)

5 \( \text{Mass is conserved} \) \( \text{Mass is conserved} \) \( \text{Mass is conserved} \)

**p118**

1 Ores are metal compounds, usually oxides, carbonates, and/or sulphides of the metal, mixed with sandy impurities.

2 Iron (Fe) is extracted from iron oxide (\( \text{Fe}_2\text{O}_3 \)) by heating at high temperatures, in a blast furnace, with carbon. \( 2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2 \)

3 Aluminium (Al) is extracted from pure aluminium oxide (\( \text{Al}_2\text{O}_3 \)) by electrolysis at high temperature (1000°C). \( 2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2 \)

4 Single replacement reaction. \( \text{Cu}_2\text{S} + \text{O}_2 \rightarrow \text{Cu} + \text{SO}_2 \)

**p119**

1 **Respiration** is the release of energy from glucose, or other carbohydrates. This energy is used for cell growth and repair.

2 **Respiration** \( \text{C}_6\text{H}_12\text{O}_6 + \text{O}_2 \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{Energy} \)

3 Respiration provides the energy for life.

4 All living organisms use respiration to provide energy.

5 \( \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 6\text{CO}_2 + \text{Energy} \)
A chemical reaction is a process in which one or more substances, the reactants, are transformed into one or more different substances, the products.

A chemical equation describes what happens in a chemical reaction. The equation shows the reactants on the left hand side, the products on the right hand side, and the chemical formulas of the substances.

X and Y are the reactants. XY is the product.

\[ \text{a)} \ C + O_2 \rightarrow CO_2 \]
\[ \text{b)} \ Zn + 2HCl \rightarrow ZnCl_2 + H_2 \]
\[ \text{c)} \ CaCO_3 \rightarrow CaO + CO_2 \]
\[ \text{d)} \ Zn + CuSO_4 \rightarrow ZnSO_4 + Cu \]
\[ \text{e)} \ H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O \]
\[ \text{f)} \ C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O \]
\[ \text{g)} \ C_12H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O \]

\[ \text{a)} \ C + O_2 \rightarrow CO_2 \]
\[ \text{b)} \ H_2 + Cl_2 \rightarrow 2HCl \]
\[ \text{c)} \ CaCO_3 \rightarrow CaO + CO_2 \]
\[ \text{d)} \ Zn + CuSO_4 \rightarrow ZnSO_4 + Cu \]
\[ \text{e)} \ H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O \]
\[ \text{f)} \ C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O \]
\[ \text{g)} \ C_12H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O \]

Zn + HCl \rightarrow ZnCl_2 + H_2

Zn = 1
H = 1
Cl = 1
Not balanced for H or Cl

H_2 + O_2 \rightarrow H_2O

H = 2
Not balanced for O

C_2H_5 + 5O_2 \rightarrow 3CO_2 + 4H_2O

C = 3
H = 8
O = 10
Balanced equation

CO_2 + 2H_2O \rightarrow 3O_2 + C_6H_{12}O_6

C = 1
O = 4
H = 4
Not balanced for C, O, or H

Fe_2O_3 + 3C \rightarrow 3CO + 2Fe

Fe = 2
O = 3
C = 3
Balanced equation

Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + 2H_2O

Mg = 1
O = 6
H = 4
S = 1
Balanced equation
12 \( \text{Cu} + \text{O}_2 \rightarrow 2\text{CuO} \)
13 \( 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \)
14 \( 2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2 \)
15 \( 2\text{NaCl} \rightarrow 2\text{Na} + \text{Cl}_2 \)
16 \( 4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3 \)
17 \( 2\text{AgNO}_3 + \text{Cu} \rightarrow \text{Cu(NO}_3)_2 + 2\text{Ag} \)
18 \( \text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 3\text{CO} + 2\text{Fe} \)
19 \( \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \)
20 \( 2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O} \)

1 A decomposition reaction occurs when a compound is chemically broken down into simpler substances.
\( \text{XY} \rightarrow \text{X} + \text{Y} \) is a decomposition reaction.
2 \( \text{XY} \) is the reactant. \( \text{X} \) and \( \text{Y} \) are the products.
3 a) and d) are the decomposition reactions (a compound broken down into simpler substances).
4 I would expect glucose to be broken down to carbon and water: \( \text{C}_6\text{H}_12\text{O}_6 \rightarrow \text{C} + \text{H}_2\text{O} \)
5 A combination reaction occurs when two or more substances combine chemically to produce one product. \( \text{X} + \text{Y} \rightarrow \text{XY} \) is a combination reaction.
6 \( \text{X} \) and \( \text{Y} \) are the products. \( \text{XY} \) is the product.
7 a) and e) are the combination reactions (producing one product).
8 \( 2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO} \)
9 \( \text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 \)

3 keg + nails = 100 pounds
keg + 0.5nails = 54 pounds
0.5nails = 100 - 54 pounds
0.5nails = 46 pounds
nails = 92 pounds
Thus keg = 8 pounds

1 A single replacement reaction occurs when an element in a compound is replaced by another element.
\( \text{XY} + \text{Z} \rightarrow \text{XZ} + \text{Y} \) is a single replacement reaction.
2 \( \text{XY} \) and \( \text{Z} \) are the reactants. \( \text{XZ} \) and \( \text{Y} \) are the products.
3 a) and c) are single replacement reactions.
4 \( \text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow 2\text{Fe} + 2\text{Al}_2\text{O}_3 \) The Al replaces the Fe in the \( \text{Fe}_2\text{O}_3 \) A single replacement.
5 A double replacement reaction occurs two compounds swap elements to produce two new compounds.
\( \text{AB} + \text{CD} \rightarrow \text{AD} + \text{CB} \) is a double replacement reaction.
6 \( \text{AB} \) and \( \text{CD} \) are the reactants. \( \text{AD} \) and \( \text{CB} \) are the products.
7 \( \text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O} \)
8 a) \( 2\text{HCl} + \text{Ca(OH)}_2 \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} \)
b) \( 2\text{HNO}_3 + \text{Mg(OH)}_2 \rightarrow \text{Mg(NO}_3)_2 + 2\text{H}_2\text{O} \)
c) \( \text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} \)

1 Reactions 2 and 4 are exothermic
2 Reaction 3 is endothermic
3 b) between 290°C and 450°C
4 a) \( \text{Ag}_2\text{CO}_3 \)

1 a) Reactants are \( \text{NaHCO}_3 \) and \( \text{C}_6\text{H}_8\text{O}_7 \). b) Products are \( \text{C}_6\text{H}_5\text{Na}_3\text{O}_7 , \text{CO}_2 , \) and \( \text{H}_2\text{O} \) e) The cool feeling is evidence of an endothermic reaction d) The fizzy feeling is probably caused by the \( \text{CO}_2 \) gas e) Yes
2 a) No - because some of the mass (\( \text{CO}_2 \)) has escaped. b) Completely seal the beaker before and after.
3 a) 12 + 32 = 44 grams (assuming all of the C combines with the \( \text{O}_2 \)) b) 16 tonnes of oxygen
4 a) double replacement b) decomposition c) combination d) single replacement
5 a) \( 2\text{Zn} + \text{O}_2 \rightarrow 2\text{ZnO} \) b) \( 4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3 \) c) \( 4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O} \)
6 a) yes b) yes c) no d) yes e) no f) no