

Chemistry
for Engineering Students 4th edition

Brown | Holme

Chapter 3

Molecules, Moles, and Chemical Equations

Edited by Dr. Katugampola

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

1

Writing Chemical Equations

- **Chemical equations** represent the transformation of one or more chemical species into new substances
 - **Reactants** are the original materials and are written on the left-hand side of the equation
 - **Products** are the newly formed compounds and are written on the right-hand side of the equation

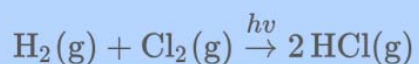
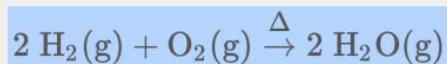
Reactants → Products

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

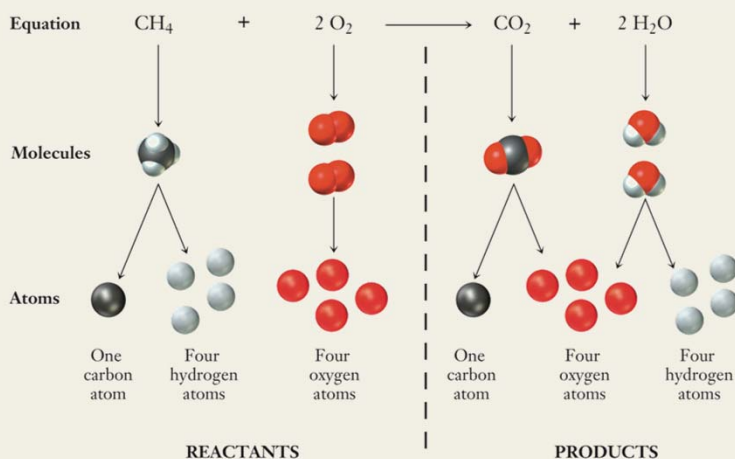
2

Writing Chemical Equations

- Chemical formulas represent reactants and products
- Physical states follow each formula
 - Solid = (s)
 - Liquid = (l)
 - Gas = (g)
 - Aqueous = (aq)
 - Substance dissolved in water
- Some reactions require an additional symbol placed over the reaction arrow to specify reaction conditions
 - Thermal reactions: Heat or high temperatures (Δ)
 - Photochemical reactions: the reaction that is initiated by light energy ($h\nu$)

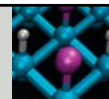


Balancing Chemical Equations



Balanced chemical equation for the combustion of methane

Balancing Chemical Equations



- The **law of conservation of matter** states that matter is neither created nor destroyed
 - ✓ Chemical reactions must obey the law of conservation of matter
 - The same number of atoms for each element must occur on both sides of the chemical equation
 - A chemical reaction simply rearranges the atoms present into different molecules

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

5

Balancing Chemical Equations (continued 2)



- Chemical equations may be balanced via **inspection**, which really means by trial and error
 - ✓ Numbers used to balance chemical equations are called **stoichiometric coefficients**

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

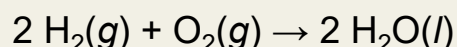
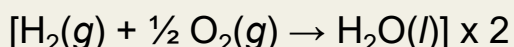
6

Guidelines for Balancing Equations

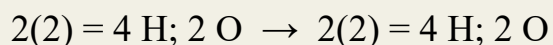
- Before placing coefficients in an equation, check that the formulas are correct.
- A **coefficient** multiplies all subscripts in a chemical formula:
 - 3 H₂O has 6 hydrogen atoms and 3 oxygen atoms.
- **Never change the subscripts** in a chemical formula to balance a chemical equation!
- Balance each element in the equation **starting with the most complex formula**.
- Balance the polyatomic ions as a single unit if it appears on both sides of the equation.

Guidelines for Balancing Equations

- The coefficients *must* be **whole numbers**.
If you get a fraction, multiply the whole equation by the denominator to get whole numbers.

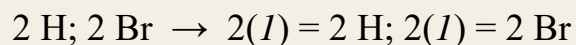
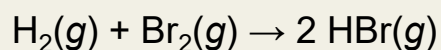
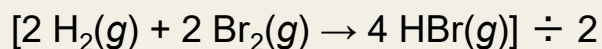


- After balancing the equation, check that there are the same number of atoms of each element (or polyatomic ion) on both sides of the equation.



Guidelines for Balancing Equations

- Finally, check that you have the **smallest whole number ratio of coefficients**. If you can divide all the coefficients by a common factor, do so to complete your balancing of the reaction.

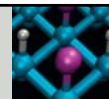


(Q.1)



- Write a balanced chemical equation describing the reaction between propane, C_3H_8 , and oxygen, O_2 , to form carbon dioxide and water

(Q.2)



Which law is reflected by the balanced chemical equation?

- Conservation of energy
- Conservation of matter
- Conservation of charge

Answer: Conservation of matter

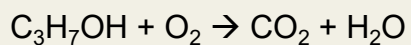
Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

11

(Q. 3)



When this equation is balanced with the smallest whole number coefficients, what is the coefficient of oxygen?



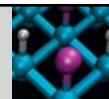
- 4
- 5
- 6
- 9

Answer: 9

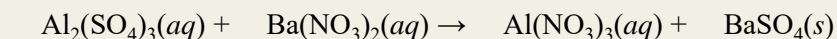
Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

12

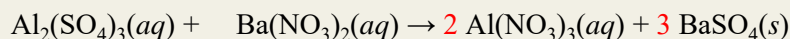
Balancing a Chemical Equation



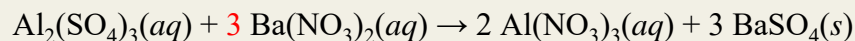
Balance the following chemical equation:



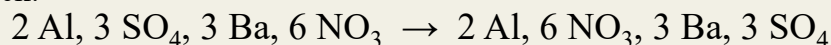
There is one SO_4 on the right and three on the left. Place a 3 in front of BaSO_4 . There are two Al on the left, and one on the right. Place a 2 in front of $\text{Al}(\text{NO}_3)_3$.



There are three Ba on the right and one on the left. Place a 3 in front of $\text{Ba}(\text{NO}_3)_2$.



Check:


Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

13

Aqueous Solutions and Net Ionic Equations



- **Reactions that occur in water** are said to take place in aqueous solution
 - ✓ **Solution:** Homogeneous mixture of two or more substances
 - **Solvent:** The major component of the solution
 - **Solute:** The minor components of the solution

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

14