شكراً لتحميلك هذا الملف من موقع المناهج الإماراتية

مراجعة شاملة وفق الهيكل الوزاري

التواصل الاجتماعي بحسب الصف الحادي عشر العام

روابط مواد الصف الحادي عشر العام على تلغرام

التربية الاسلامية	اللغة العربية	اللغة الانجليزية	الرياضيات

المزيد من الملفات بحسب الصف الحادي عشر العام والمادة كيمياء في الفصل الثاني

1	مراجعة شاملة وفق الهيكل الوزاري
2	حل أسئلة الامتحان الوزاري
3	نموذج الهيكل الوزاري - بريدج
4	دليل المعلم الوحدة الرابعة التفاعلات الكيميائية
5	أوراق عمل الوحدة الرابعة التفاعلات الكيميائية مع الإجابة النموذجية

CHEMISTRY

Term 2 Exam Revision

هيكل امتحان نهاية الفصل الدراسي الثاني

GRADE 11

EMAN ALHELALI - ALKHAIR SCOOL

CHAPTER 4

CHEMICAL REACTION

Question #	Learning Outcomes	References in the student book	
1	Represent chemical reactions using different types of equations while illustrating their balancing process and its relation to the law of conservation of mass يمثل التفاعلات الكيميائية باستخدام أنواع المعادلات المختلفة موضحًا عمليّة وزنها وعلاقتها بقانون حفظ الكتلة	Figure 2 الشكل 2	113

Figure 9.2 Each of these photos illustrates evidence of a chemical reaction.
Describe *the evidence in each photo that tells you a chemical reaction has occurred.*

Change in color
Bleaching hair changes its color.

Change in temperature
Burning wood produces heat.

Production of a gas
Dissolving an antacid tablet in water produces gas bubbles.

Production of a solid
Adding acid to milk produces solid curds of cottage cheese

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book	
2	Represent chemical reactions using different types of equations while illustrating their balancing process and its relation to the law of conservation of mass يمثّل التفاعلات الكيميائية باستخدام أنواع المعادلات المختلفة موضحًا عمليّة وزنها وعلاقتها بقانون حفظ الكتلة	Table 1 جدول 1	113

Table 9.1 Symbols Used in Equations	
Symbol	**Purpose**
+	separates two or more reactants or products
→	separates reactants from products
⇌	separates reactants from products and indicates a reversible reaction
(s)	identifies a solid state
(l)	identifies a liquid state
(g)	identifies a gaseous state
(aq)	identifies a water solution

PARTS OF CHEMICAL EQUATIONS

Reactants are the initial components (starting substances).
Products are the resultant components (substances formed during the reaction).

Arrows: They separate reactants from products and specify direction

A coefficient is the number written in front of a reactant or a product that is used to balance chemical equations.
Coefficients: They specify the relative amount of the components

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book	
3	Represent chemical reactions using different types of equations while illustrating their balancing process and its relation to the law of conservation of mass يمثّل التفاعلات الكيميائية باستخدام أنواع المعادلات المختلفة موضحا عمليّة وزنها وعلاقتها بقانون حفظ الكتلة	Example1+ application questions مثال 1+ أسئلة التطبيقات	117

EXAMPLE Problem 9.1

Writing a Balanced Chemical Equation Write the balanced chemical equation for the reaction in which aqueous sodium hydroxide and aqueous calcium bromide react to produce solid calcium hydroxide and aqueous sodium bromide.

1 Analyze the Problem

You are given the reactants and products in a chemical reaction. Start with a skeleton equation, and use the steps given in **Table 9.2** for balancing chemical equations.

Math Handbook
Ratios
page 964

2 Solve for the Unknown

Write the skeleton equation for the chemical reaction. Be sure to put the reactants on the left side of the arrow and the products on the right. Separate the substances with plus signs, and indicate their physical states.

$$NaOH(aq) + CaBr_2(aq) \rightarrow Ca(OH)_2(s) + NaBr(aq)$$

1 Na, 1 O, 1 H, 1 Ca, 2 Br	Count the atoms of each element in the reactants.
1 Na, 2 O, 2 H, 1 Ca, 1 Br	Count the atoms of each element in the products.
$2NaOH + CaBr_2 \rightarrow Ca(OH)_2 + NaBr$	Insert the coefficient 2 in front of NaOH to balance the hydroxide ions.
$2NaOH + CaBr_2 \rightarrow Ca(OH)_2 + 2NaBr$	Insert the coefficient 2 in front of NaBr to balance the Na and Br atoms.
The ratio of the coefficients is 2:1:1:2.	Write the coefficients in their lowest-possible ratio.
Reactants: 2 Na, 2 OH, 1 Ca, 2 Br Products: 2 Na, 2 OH, 1 Ca, 2 Br	Check to make sure that the number of atoms of each element is equal on both sides of the equation.

3 Evaluate the Answer

The chemical formulas for all substances are written correctly. The number of atoms of each element is equal on both sides of the equation. The coefficients are written in the lowest possible ratio. The balanced chemical equation for the reaction is

$$2NaOH(aq) + CaBr_2(aq) \rightarrow Ca(OH)_2(s) + 2NaBr(aq)$$

WORD EQUATION

Sodiuom hydroxide(aq) + Calsuim Bromide (aq)----→ Calcuim Hydroxide (s) + Soduom Bromide (aq)

SKELTON EQUATION

$$NaOH(aq) + CaBr2(aq) \text{ ------> } Ca(OH)2(s) + NaBr(aq)$$

BALANCE CHEMICAL EQUATION

$$2\,NaOH(aq) + CaBr2(aq) \text{ ------> } Ca(OH)2(s) + 2\,NaBr(aq)$$

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book	
3	Represent chemical reactions using different types of equations while illustrating their balancing process and its relation to the law of conservation of mass يمثّل التفاعلات الكيميائية باستخدام أنواع المعادلات المختلفة موضحًا عمليّة وزنها وعلاقتها بقانون حفظ الكتلة	Example1+ application questions مثال 1+ أسئلة التطبيقات	117

PRACTICE Problems Extra Practice Page 980 and glencoe.com

Write chemical equations for each of the following reactions.

4. In water, iron(III) chloride reacts with sodium hydroxide, producing solid iron(III) hydroxide and sodium chloride.
5. Liquid carbon disulfide reacts with oxygen gas, producing carbon dioxide gas and sulfur dioxide gas.
6. **Challenge** A piece of zinc metal is added to a solution of hydrogen sulfate. This reaction produces a gas and a solution of zinc sulfate.

QUESTION 4

SKELTON EQUATION

$$FeCl_3(aq) + NaOH(aq) \dashrightarrow Fe(OH)_3(s) + NaCl(aq)$$

CHEMICAL EQUATION

$$FeCl_3(aq) + 3NaOH(aq) \dashrightarrow Fe(OH)_3(s) + 3NaCl(aq)$$

QUESTION 5

SKELTON EQUATION

$$CS_2(l) + O_2(g) \dashrightarrow CO_2(g) + SO_2(g)$$

BALANCE CHEMICAL EQUATION

$$CS_2(l) + 3O_2(g) \dashrightarrow CO_2(g) + 2SO_2(g)$$

QUESTION 6

SKELTON EQUATION

$$Zn(s) + H_2SO_4(aq) \dashrightarrow ZnSO_4(aq) + H_2(g)$$

BALANCE CHEMICAL EQUATION

$$Zn(s) + H_2SO_4(aq) \dashrightarrow ZnSO_4(aq) + H_2(g)$$

CHAPTER 4 : CHEMICAL REACTION

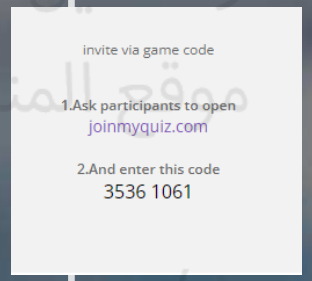
SECTION 1: REACTIONS AND EQUATIONS

Key Words

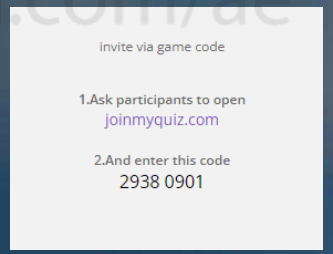
- **Chemical reaction**
- **Balance equation**
- **Reactant**
- **Product**
- **Coefficient**
- **Subscript**

ASSESMENT ON QUIZZEZ

DEFINE CHEMICAL EQUATION :
https://quizizz.com/join?gc=35361061



BALANCE CHEMICAL EQUATION
https://quizizz.com/join?gc=29380901



LESSON SUMMARY :
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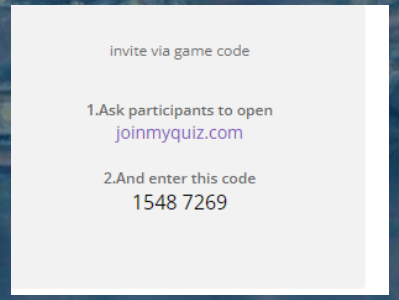


Question #	Learning Outcomes	References in the student book	
5	Write balanced chemical equations to represent the various types of chemical reactions, and combustion reactions, using the IUPAC nomenclature system يكتب معادلات كيميائية موزونة تمثل الأنواع المختلفة من التفاعلات الكيميائية مستخدما نظام المصطلحات الخاص بالاتحاد الدولي للكيمياء البحتة والتطبيقية	Text book نص الكتاب	119

BOOK REFERENCE

Synthesis Reactions

In **Figure 9.7,** sodium and chlorine react to produce sodium chloride. This reaction is a **synthesis reaction**—a chemical reaction in which two or more substances (A and B) react to produce a single product (AB).

$$A + B \rightarrow AB$$

When two elements react, the reaction is always a synthesis reaction.

Two compounds can also combine to form one compound. For example, the reaction between calcium oxide (CaO) and water (H_2O) to form calcium hydroxide ($Ca(OH)_2$) is a synthesis reaction.

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$$

Another type of synthesis reaction involves a reaction between a compound and an element, as happens when sulfur dioxide gas (SO_2) reacts with oxygen gas (O_2) to form sulfur trioxide (SO_3).

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

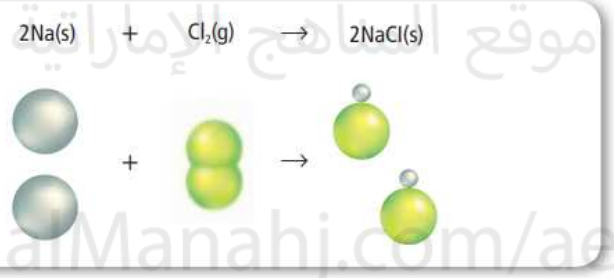
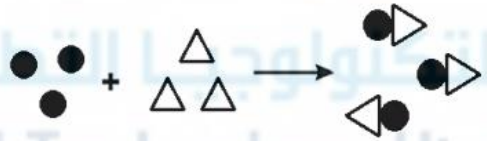


Figure 9.7 In this synthesis reaction, two elements, sodium and chlorine, react to produce one compound, sodium chloride.

SAMMARY

Synthesis Reaction is a chemical reaction in which two or more substances react to produce a single product

General Equation:	$X + Y \rightarrow XY$
Particulate Diagram:	
Examples:	$Fe_{(s)} + S_{(s)} \rightarrow FeS_{(s)}$ $2Al_{(s)} + 3Br_{2(g)} \rightarrow 2AlBr_{3(s)}$ $2Cu_{(s)} + O_{2(g)} \rightarrow 2CuO_{(s)}$ 

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book
5	Write balanced chemical equations to represent the various types of chemical reactions, and combustion reactions, using the IUPAC nomenclature system يكتب معادلات كيميائية موزونة تمثل الأنواع المختلفة من التفاعلات الكيميائية مستخدما نظام المصطلحات الخاص بالاتحاد الدولي للكيمياء البحتة والتطبيقية	Text book نص الكتاب 119

BOOK REFERENCE

Combustion Reactions

The synthesis reaction between sulfur dioxide and oxygen can also be classified as a combustion reaction. In a **combustion reaction,** such as the one shown in **Figure 9.8,** oxygen combines with a substance and releases energy in the form of heat and light. Oxygen can combine in this way with many different substances, making combustion reactions common. To learn more about the discovery of the chemical reaction for combustion and other reactions, review **Figure 9.9.**

A combustion reaction occurs between hydrogen and oxygen when hydrogen is heated, as illustrated in **Figure 9.10.** Water is formed during the reaction, and a large amount of energy is released. Another important combustion reaction occurs when coal is burned to produce energy. Coal is called a fossil fuel because it contains the remains of plants that lived long ago. It is composed primarily of the element carbon. Coal-burning power plants generate electric power in many parts of the United States. The primary reaction that occurs in these plants is between carbon and oxygen.

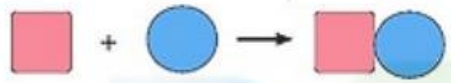
$$C(s) + O_2(g) \rightarrow CO_2(g)$$

Note that the combustion reactions just mentioned are also synthesis reactions. However, not all combustion reactions are synthesis reactions. For example, the reaction involving methane gas (CH_4) and oxygen illustrates a combustion reaction in which one substance replaces another in the formation of products.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

SAMMARY

Combustion reaction is a simple type of synthesis reaction, where a substance combines with oxygen and releases energy in the form of heat and light.

General Equation:	$X + O_2 \rightarrow XO_2$
Particulate Diagram:	
Examples:	$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$ $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $C_3H_{8\,(g)} + 5\ O_{2\,(g)} \rightarrow 3\ CO_{2\,(g)} + 4\ H_2O_{\,(l)}$ $2\ C_2H_{6(g)} + 7\ O_{2(g)} \rightarrow 4\ CO_{2(g)} + 6\ H_2O_{(l)}$ $C_3H_6O_{(l)} + 4\ O_{2(g)} \rightarrow 3\ CO_{2(g)} + 3\ H_2O_{(l)}$

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book	
5	Write balanced chemical equations to represent the various types of chemical reactions, and combustion reactions, using the IUPAC nomenclature system يكتب معادلات كيميائية موزونة تمثل الأنواع المختلفة من التفاعلات الكيميائية مستخدما نظام المصطلحات الخاص بالاتحاد الدولي للكيمياء البحتة والتطبيقية	Text book نص الكتاب	119

BOOK REFERENCE

Decomposition Reactions

Some chemical reactions are essentially the opposite of synthesis reactions. These reactions are classified as decomposition reactions. A **decomposition reaction** is one in which a single compound breaks down into two or more elements or new compounds. In generic terms, decomposition reactions can be represented as follows.

$$AB \longrightarrow A + B$$

Decomposition reactions often require an energy source, such as heat, light, or electricity, to occur. For example, ammonium nitrate breaks down into dinitrogen monoxide and water when the reactant is heated to a high temperature.

$$NH_4NO_3(s) \longrightarrow N_2O(g) + 2H_2O(g)$$

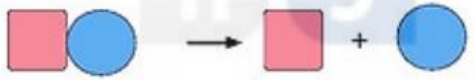
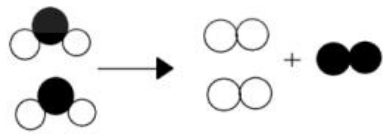
Notice that this decomposition reaction involves one reactant breaking down into more than one product.

The outcome of another decomposition reaction is shown in **Figure 9.11.** Automobile safety air bags inflate rapidly as sodium azide pellets decompose. A device that can provide an electric signal to start the reaction is packaged inside air bags along with the sodium azide pellets. When the device is activated, sodium azide decomposes, producing nitrogen gas that quickly inflates the air bag.

$$2NaN_3(s) \longrightarrow 2Na(s) + 3N_2(g)$$

SAMMARY

Decomposition reaction is a chemical reaction in which a single compound breaks into two or more elements or new compounds

General Equation:	$XY \rightarrow X + Y$
Particulate Diagram:	
Examples:	$2\ NaCl \rightarrow 2\ Na + Cl_2$ $K_2CO_{3(s)} \xrightarrow{\Delta} K_2O_{(s)} + CO_{2(g)}$ $CaCO_3 \rightarrow CaO + CO_2$ 

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book	
4	Represent chemical reactions using different types of equations while illustrating their balancing process and its relation to the law of conservation of mass يمثّل التفاعلات الكيميائية باستخدام أنواع المعادلات المختلفة موضحًا عمليّة وزنها وعلاقتها بقانون حفظ الكتلة	Text book نص الكتاب	122

PRACTICE Problems

Extra Practice Page 980 and glencoe.com

Write chemical equations for the following decomposition reactions.

18. Aluminum oxide(s) decomposes when electricity passes through it.

19. Nickel(II) hydroxide(s) decomposes to produce nickel(II) oxide(s) and water.

20. Challenge Heating sodium hydrogen carbonate(s) produces sodium carbonate(aq) and water. Carbon dioxide gas is also produced.

Write chemical equations for the following decomposition reactions.

18. Aluminum oxide(s) decomposes when electricity is passed through it.

$$2Al_2O_3(s) \rightarrow 4Al(s) + 3O_2(g)$$

19. Nickel(II) hydroxide(s) decomposes to produce nickel(II) oxide(s) and water.

$$Ni(OH)_2(s) \rightarrow NiO(s) + H_2O(l)$$

20. Challenge Heating sodium hydrogen carbonate(s) produces sodium carbonate(aq) and water. Carbon dioxide gas is also produced.

$$2NaHCO_3(s) \rightarrow Na_2CO_3(aq) + CO_2(g) + H_2O(l)$$

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book	
6	Predict the products of single displacement reactions, using the metals and halogens reactivity series يتنبأ بنواتج تفاعلات الاستبدال الأحادي مستخدما سلسلة نشاطية الفلزات وسلسلة نشاطية الهالوجينات	Example2+ application questions مثال 2+ أسئلة التطبيقات	125

BOOK REFERENCE – 2 مثال

Replacement Reactions

In contrast to synthesis, combustion, and decomposition reactions, many chemical reactions are replacement reactions and involve the replacement of an element in a compound. These reactions are also called displacement reactions. There are two types of replacement reactions: single-replacement reactions and double-replacement reactions.

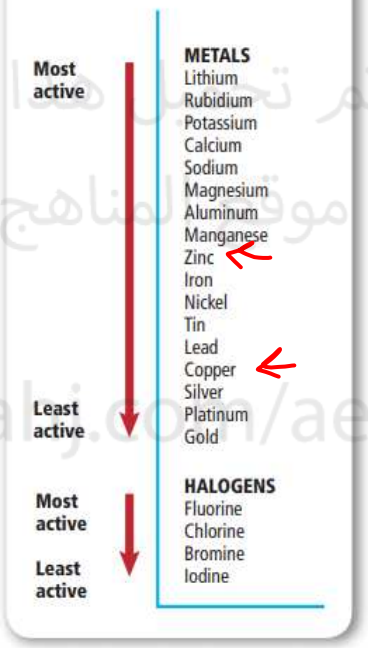
Single-replacement reactions The reaction between lithium and water is shown in **Figure 9.12.** The following chemical equation shows that a lithium atom replaces one of the hydrogen atoms in a water molecule.

$$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$$

A reaction in which the atoms of one element replace the atoms of another element in a compound is called a **single-replacement reaction.**

$$A + BX \rightarrow AX + B$$

Figure 9.13 An activity series, similar to the series shown here for various metals and halogens, is a useful tool for determining whether a chemical reaction will occur and for determining the result of a single-replacement reaction.



SAMMARY

Single-replacement reaction is a chemical reaction in which the atoms of one element replace the atoms of another element in a compound

General Equation:	$X + YZ \rightarrow XZ + Y$
Particulate Diagram:	
Examples: element + Compound	$Zn_{(s)} + CuSO_{4(aq)} \rightarrow ZnSO_{4(aq)} + Cu_{(s)}$ $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$ $Cl_{2(g)} + 2KBr_{(aq)} \rightarrow 2KCl_{(aq)} + Br_{2(l)}$ $MQ + Z \rightarrow ZQ + M$

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book
6	Predict the products of single displacement reactions, using the metals and halogens reactivity series يتنبأ بنواتج تفاعلات الاستبدال الأحادي مستخدما سلسلة نشاطية الفلزات وسلسلة نشاطية الهالوجينات	Example2+ application questions مثال 2+ أسئلة التطبيقات 125

BOOK REFERENCE – مثال 2 صفحة 125

EXAMPLE Problem 9.2

Single-Replacement Reactions Predict the products that will result when these reactants combine, and write a balanced chemical equation for each reaction.

a. $Fe(s) + CuSO_4(aq) \rightarrow$

b. $Br_2(l) + MgCl_2(aq) \rightarrow$

c. $Mg(s) + AlCl_3(aq) \rightarrow$

1 Analyze the Problem

You are given three sets of reactants. Using **Figure 9.13,** you must first determine if each reaction occurs. Then, if a reaction is predicted, you can determine the product(s) of the reaction. With this information you can write a skeleton equation for the reaction. Finally, you can use the steps for balancing chemical equations to write the complete balanced chemical equation.

2 Solve for the Unknown

a. Iron is listed above copper in the activity series. Therefore, the first reaction will occur because iron is more reactive than copper. In this case, iron will replace copper. The skeleton equation for this reaction is

$$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$$

This equation is balanced.

b. In the second reaction, chlorine is more reactive than bromine because bromine is listed below chlorine in the activity series. Therefore, the reaction will not occur. The skeleton equation for this situation is

$$Br(l) + MgCl_2(aq) \rightarrow NR$$

No balancing is required.

c. Magnesium is listed above aluminum in the activity series. Therefore, the third reaction will occur because magnesium is more reactive than aluminum. In this case, magnesium will replace aluminum. The skeleton equation for this reaction is

$$Mg(s) + AlCl_3(aq) \rightarrow Al(s) + MgCl_2(aq)$$

This equation is not balanced. The balanced equation is

$$3Mg(s) + 2AlCl_3(aq) \rightarrow 2Al(s) + 3MgCl_2(aq)$$

3 Evaluate the Answer

The activity series shown in **Figure 9.13** supports the reaction predictions. The chemical equations are balanced because the number of atoms of each substance is equal on both sides of the equation.

EXAMPLE Problem 9.2

Single-Replacement Reactions Predict the products that will result when these reactants combine, and write a balanced chemical equation for each reaction.

a. $Fe(s) + CuSO_4(aq) \rightarrow$ $FeSO4(aq) + Cu(s)$ حسب سلسلة النشاط الحديد انشط من النحاس

b. $Br_2(l) + MgCl_2(aq) \rightarrow$ NR حسب سلسلة النشاط الكلور انشط من البروم

c. $Mg(s) + AlCl_3(aq) \rightarrow$ $MgCl2(aq) + Al(s)$ حسب سلسلة النشاط المغنيسيوم انشط من الالومنيوم

Application Questions

PRACTICE Problems

Extra Practice Pages 980–981 and glencoe.com

Predict whether the following single-replacement reactions will occur. If a reaction occurs, write a balanced equation for the reaction.

21. $K(s) + ZnCl_2(aq) \rightarrow$

22. $Cl_2(g) + HF(aq) \rightarrow$

23. $Fe(s) + Na_3PO_4(aq) \rightarrow$

24. Challenge $Al(s) + Pb(NO_3)_2(aq) \rightarrow$

21) $K(s) + ZnCl_2(aq) \rightarrow$

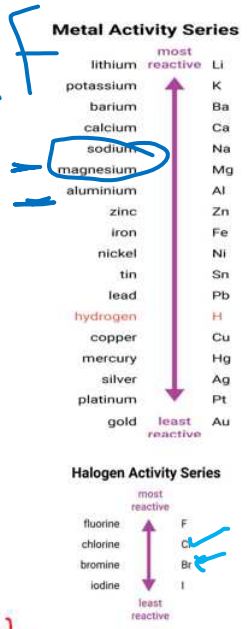
Sol: K is more active than Zn

$2K + ZnCl_2 \rightarrow Zn + 2KCl$

22) $Cl_2 + HF \rightarrow NR$

23) $Fe + Na_3PO_4 \rightarrow NR$

24) $2Al + 3Pb(NO_3)_2 \rightarrow 3Pb + 2Al(NO_3)_3$



Question #	Learning Outcomes	References in the student book	
21	Interpret the different type of chemical reaction that can occur under different reaction conditions and in various reaction mediums يفسّر الأنواع المختلفة من التفاعلات الكيميائية التي يمكن أن تحدث في ظل ظروف تفاعل مختلفة وفي أوساط تفاعل متنوّعة	Text book نص الكتاب	126

BOOK REFERENCE

Double-replacement reactions The final type of replacement reaction, which involves an exchange of ions between two compounds, is called a **double-replacement reaction.**

In the generic equation in **Figure 9.14,** A and B represent positively charged ions (cations), and X and Y represent negatively charged ions (anions). Notice that the anions have switched places and are now bonded to the other cations in the reaction. In other words, X replaces Y and Y replaces X—a double replacement. More simply, the positive and negative ions of two compounds switch places.

The reaction between calcium hydroxide and hydrochloric acid is a double-replacement reaction.

$$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

The ionic components of the reaction are Ca^{2+}, OH^-, H^+, and Cl^-. Knowing this, you can now see the two replacements of the reaction. The anions (OH^- and Cl^-) have changed places and are now bonded to the other cations (Ca^{2+} and H^+), as shown in **Figure 9.14.**

The reaction between sodium hydroxide and copper(II) chloride in solution is also a double-replacement reaction.

$$2NaOH(aq) + CuCl_2(aq) \rightarrow 2NaCl(aq) + Cu(OH)_2(s)$$

In this case, the anions (OH^- and Cl^-) changed places and bonded to the other cations (Na^+ and Cu^{2+}). **Figure 9.15** shows that the result of this reaction is a solid product, copper(II) hydroxide. A solid produced during a chemical reaction in a solution is called a **precipitate.**

SAMMARY

Double replacement is a chemical reaction that involves exchange of ions between two compounds.

General Equation:	$XY + WZ \rightarrow XZ + WY$
Particulate Diagram:	
Examples:	$Ca(OH)_{2(aq)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + 2H_2O_{(l)}$ $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$ $2NaOH_{(aq)} + FeCl_{2(aq)} \rightarrow Fe(OH)_{2(s)} + 2NaCl_{(aq)}$ $FeCl_{3(aq)} + 3NaOH_{(aq)} \rightarrow Fe(OH)_{3(s)} + 3NaCl_{(aq)}$

Compound + Compound

CHAPTER 4 BOCKLET.pdf

CHAPTER 4 : CHEMICAL REACTION
SECTION 2:CLASSIFYING CHEMICAL REACTIONS

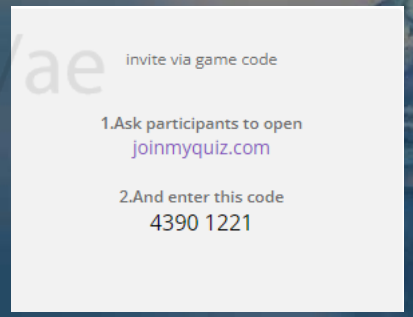
Key Words

- **Chemical reaction**
- **Synthesis**
- **Decomposition**
- **Single replacement**
- **Double replacement**

ASSESMENT ON QUIZZEZ

Lesson : https://quizizz.com/join?gc=15720741

Assessment : https://quizizz.com/join?gc=43901221



Question #	Learning Outcomes	References in the student book
7	Explain the chain of chemical reactions that can occur in aqueous solutions يفسّر سلسلة التفاعلات الكيميائية التي يمكن أن تحدث في المحاليل المائية	Text book نص الكتاب 129

BOOK REFERENCE

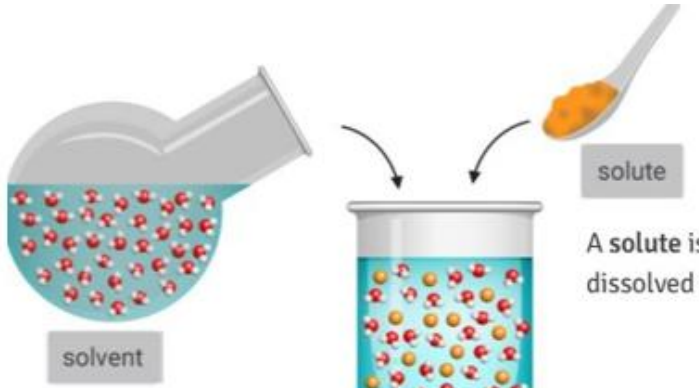
Aqueous Solutions

You read in Chapter 3 that a solution is a homogeneous mixture. Many of the reactions discussed in the previous section involve substances dissolved in water. When a substance dissolves in water, a solution forms. An **aqueous solution** contains one or more substances called **solutes** dissolved in the water. In this case, water is the **solvent**—the most plentiful substance in the solution.

Molecular compounds in solution Although water is always the solvent in aqueous solutions, there are many possible solutes. Some solutes, such as sucrose (table sugar) and ethanol (grain alcohol), are molecular compounds that exist as molecules in aqueous solutions. Other solutes are molecular compounds that form ions when they dissolve in water. For example, the molecular compound hydrogen chloride forms hydrogen ions and chloride ions when it dissolves in water, as shown in **Figure 9.16.** An equation can be used to show this ionization process.

$$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$$

Compounds such as hydrogen chloride that produce hydrogen ions in aqueous solution are acids. In fact, an aqueous solution of hydrogen chloride is often referred to as hydrochloric acid. You will read more about acids in Chapter 18.



A **solvent** is a liquid that is used to dissolve other substances in.

A **solute** is the substance that is dissolved in the solvent.

An **aqueous solution** is a solution where water is the solvent.

chemical equation uses chemical symbols and formulas to show the reactants and the products in a chemical reaction.

A **complete ionic equation** is a balanced equation that shows all the individual ions that are present in solution.

A **net ionic equation** is a balanced equation that only shows the ions that take place in the reaction in solution.

Spectator ions are ions that do not take part in the chemical reaction.

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book	
8	Write balanced chemical equations to represent the various types of chemical reactions, and combustion reactions, using the IUPAC nomenclature system يكتب معادلات كيميائية موزونة تمثل الأنواع المختلفة من التفاعلات الكيميائية مستخدما نظام المصطلحات الخاص بالاتحاد الدولي للكيمياء البحتة والتطبيقية	Example3+ application questions مثال 3+ أسئلة التطبيقات	132

BOOK REFERENCE- Example 3

EXAMPLE Problem 9.3

Reactions That Form a Precipitate Write the chemical, complete ionic, and net ionic equations for the reaction between aqueous solutions of barium nitrate and sodium carbonate that forms the precipitate barium carbonate.

WORD EQUATION Barium Nitrate (aq) + Sodium Carbonate(aq) ------→ Barium Carbonate (s)+ sodium nitrate (aq)

SKELTON EQUATION $Ba(NO3)2(aq) + Na2CO3(aq) \text{-------} > BaCO3(S) + NaNO3(aq)$

BALANCE CHEMICAL EQUATION $Ba(NO3)2(aq) + Na2CO3(aq) \text{-------} > BaCO3(S) + 2NaNO3(aq)$

Complete ionic equation $Ba^{+2}(aq) + 2NO3^{-}(aq) + 2Na^{+}(aq) + CO3^{-2}(aq) \text{-----} > BaCO3(s) + 2Na^{+}(aq) + 2NO3^{-}(aq)$

Spectator ions $2NO3^{-}(aq)$ $2Na^{+}(aq)$

Net Ionic equation $Ba^{+2}(aq) + CO3^{-2}(aq) \text{-----} > BaCO3(s)$

الايونات المتفرجة $2NO3^{-}(aq) + 2Na^{+}(aq)$

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book	
8	Write balanced chemical equations to represent the various types of chemical reactions, and combustion reactions, using the IUPAC nomenclature system يكتب معادلات كيميائية موزونة تمثل الأنواع المختلفة من التفاعلات الكيميائية مستخدما نظام المصطلحات الخاص بالاتحاد الدولي للكيمياء البحتة والتطبيقية	Example3+ application questions مثال 3+ أسئلة التطبيقات	132

REACTION TO FORM PRECIPITATE

Application Questions

PRACTICE Problems — Extra Practice Page 981 and glencoe.com

Write chemical, complete ionic, and net ionic equations for each of the following reactions that might produce a precipitate. Use *NR* to indicate that no reaction occurs.

35. Aqueous solutions of potassium iodide and silver nitrate are mixed, forming the precipitate silver iodide.

36. Aqueous solutions of ammonium phosphate and sodium sulfate are mixed. No precipitate forms and no gas is produced.

37. Aqueous solutions of aluminum chloride and sodium hydroxide are mixed, forming the precipitate aluminum hydroxide.

38. Aqueous solutions of lithium sulfate and calcium nitrate are mixed, forming the precipitate calcium sulfate.

39. Challenge When aqueous solutions of sodium carbonate and manganese(V) chloride are mixed, a precipitate forms. The precipitate is a compound containing manganese.

ANSWERS IN NEXT SLIDE

TO SOLVE THIS QUESTION INCLUDE THE FOLLOWING STEPS

BALANCE CHEMICAL EQUATION

Complete ionic equation

Spectator ions

Net Ionic equation

CHAPTER 4 BOCKLET.pdf

ANSWERS

35. Aqueous solutions of potassium iodide and silver nitrate are mixed, forming the precipitate silver iodide.

BALANCE CHEMICAL EQUATION

$$KI(aq) + AgNO3(aq) \text{ ------> } AgI(s) + KNO3(aq)$$

Complete ionic equation

$$K^{+}(aq) + I^{-}(aq) + Ag^{+}(aq) + NO3^{-}(aq) \text{ ------> } AgI(s) + K^{+}(aq) + NO3^{-}(aq)$$

Net Ionic equation

$$I^{-}(aq) + Ag^{+}(aq) \text{ ------> } AgI(s)$$

Spectator ions

$$K^{+}(aq) + NO3^{-}(aq)$$

37. Aqueous solutions of aluminum chloride and sodium hydroxide are mixed, forming the precipitate aluminum hydroxide.

BALANCE CHEMICAL EQUATION

$$AlCl3(aq) + 3NaOH(aq) \text{ ----------> } Al(OH)3(s) + 3NaCl3(aq)$$

Complete ionic equation

$$Al(aq) + 3Cl(aq) + 3Na(aq) + 3OH(aq) \text{ -------> } Al(OH)3(s) + 3Na(aq) + 3Cl(aq)$$

Net Ionic equation

$$Al(aq) + 3OH(aq) \text{ -------> } Al(OH)3(s)$$

Spectator ions

$$3Na(aq) + 3Cl(aq)$$

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book
8	Write balanced chemical equations to represent the various types of chemical reactions, and combustion reactions, using the IUPAC nomenclature system يكتب معادلات كيميائية موزونة تمثل الأنواع المختلفة من التفاعلات الكيميائية مستخدما نظام المصطلحات الخاص بالاتحاد الدولي للكيمياء البحتة والتطبيقية	Example3+ application questions مثال 3+ أسئلة التطبيقات 132

PRACTICE Problems

Extra Practice Page 981 and glencoe.com

Write chemical, complete ionic, and net ionic equations for each of the following reactions that might produce a precipitate. Use *NR* to indicate that no reaction occurs.

35. Aqueous solutions of potassium iodide and silver nitrate are mixed, forming the precipitate silver iodide.

36. Aqueous solutions of ammonium phosphate and sodium sulfate are mixed. No precipitate forms and no gas is produced.

37. Aqueous solutions of aluminum chloride and sodium hydroxide are mixed, forming the precipitate aluminum hydroxide.

38. Aqueous solutions of lithium sulfate and calcium nitrate are mixed, forming the precipitate calcium sulfate.

39. Challenge When aqueous solutions of sodium carbonate and manganese(V) chloride are mixed, a precipitate forms. The precipitate is a compound containing manganese.

ANSWERS

36. Aqueous solutions of ammonium phosphate and sodium sulfate are mixed. No precipitate forms and no gas is produced.

chemical equation: $2(NH_4)_3PO_4(aq) + 3Na_2SO_4(aq) \rightarrow 3(NH_4)_2SO_4(aq) + 2Na_3PO_4(aq)$

complete ionic equation: $\cancel{6NH_4^+}(aq) + \cancel{2PO_4^{3-}}(aq) + \cancel{6Na^+}(aq) + \cancel{3SO_4^{2-}}(aq) \rightarrow \cancel{6NH_4^+}(aq) + \cancel{3SO_4^{2-}}(aq) + \cancel{6Na^+}(aq) + \cancel{2PO_4^{3-}}(aq)$

No reaction occurs; therefore, there is no net ionic equation.

38. Aqueous solutions of lithium sulfate and calcium nitrate are mixed, forming the precipitate calcium sulfate.

chemical equation: $Li_2SO_4(aq) + Ca(NO_3)_2(aq) \rightarrow 2LiNO_3(aq) + CaSO_4(s)$

complete ionic equation: $\cancel{2Li^+}(aq) + SO_4^{2-}(aq) + Ca^{2+}(aq) + \cancel{2NO_3^-}(aq) \rightarrow \cancel{2Li^+}(aq) + \cancel{2NO_3^-}(aq) + CaSO_4(s)$

net ionic equation: $SO_4^{2-}(aq) + Ca^{2+}(aq) \rightarrow CaSO_4(s)$

39. Challenge When aqueous solutions of sodium carbonate and manganese(V) chloride are mixed, a precipitate forms. The precipitate is a compound containing manganese.

chemical equation: $5Na_2CO_3(aq) + 2MnCl_5(aq) \rightarrow 10NaCl(aq) + Mn_2(CO_3)_5(s)$

complete ionic equation: $\cancel{10Na^+}(aq) + 5CO_3^{2-}(aq) + 2Mn^{5+}(aq) + \cancel{10Cl^-}(aq) \rightarrow \cancel{10Na^+}(aq) + \cancel{10Cl^-}(aq) + Mn_2(CO_3)_5(s)$

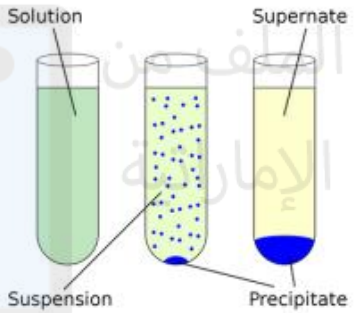
net ionic equation: $5CO_3^{2-}(aq) + 2Mn^{5+}(aq) \rightarrow Mn_2(CO_3)_5(s)$

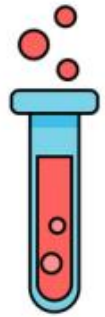
CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book
9	Explain the chain of chemical reactions that can occur in aqueous solutions يفسّر سلسلة التفاعلات الكيميائية التى يمكن أن تحدث فى المحاليل المائية	Example4+ application questions مثال 4+ أسئلة التطبيقات 134

Type of Reactions in Aqueous Solutions

Reactions that form Precipitate	Reactions that form Water	Reactions that form Gases





Examples

$2OH^-(aq) + Cu^{2+}(aq) \rightarrow Cu(OH)_2(s)$

Examples

$HBr(aq) + NaOH(aq) \rightarrow H_2O(l) + NaBr(aq)$

Examples

$H_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g)$

CHAPTER 4 BOCKLET.pdf

Question #	Learning Outcomes	References in the student book
9	Explain the chain of chemical reactions that can occur in aqueous solutions يفسّر سلسلة التفاعلات الكيميائية التي يمكن أن تحدث في المحاليل المائية	Example4+ application questions مثال 4+ أسئلة التطبيقات 134

REACTION TO FORM WATER

BOOK REFERENCE- Example 4

EXAMPLE Problem 9.4

Reactions That Form Water Write the chemical, complete ionic, and net ionic equations for the reaction between hydrochloric acid and aqueous lithium hydroxide. This reaction produces water and aqueous lithium chloride.

1 Analyze the Problem

You are given the word equation for the reaction that occurs between hydrochloric acid and aqueous lithium hydroxide to produce water and aqueous lithium chloride. You must determine the chemical formulas for and relative amounts of all reactants and products to write the balanced chemical equation. To write the complete ionic equation, you need to show the ionic states of the reactants and products. By crossing out the spectator ions from the complete ionic equation, you can write the net ionic equation.

2 Solve for the Unknown

Write the skeleton equation for the reaction and balance it.

$HCl(aq) + LiOH(aq) \rightarrow H_2O(l) + LiCl(aq)$

$H^+(aq) + Cl^-(aq) + Li^+(aq) + OH^-(aq) \rightarrow H_2O(l) + Li^+(aq) + Cl^-(aq)$ — Show the ions of the reactants and the products.

$H^+(aq) + \cancel{Cl^-(aq)} + \cancel{Li^+(aq)} + OH^-(aq) \rightarrow H_2O(l) + \cancel{Li^+(aq)} + \cancel{Cl^-(aq)}$ — Cross out the spectator ions from the complete ionic equation.

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ — Write the net ionic equation.

Application Questions

PRACTICE Problems — Extra Practice Page 981 and glencoe.com

Write chemical, complete ionic, and net ionic equations for the reactions between the following substances, which produce water.

40. Mixing sulfuric acid (H_2SO_4) and aqueous potassium hydroxide produces water and aqueous potassium sulfate.

41. Mixing hydrochloric acid (HCl) and aqueous calcium hydroxide produces water and aqueous calcium chloride.

42. Mixing nitric acid (HNO_3) and aqueous ammonium hydroxide produces water and aqueous ammonium nitrate.

43. Mixing hydrosulfuric acid (H_2S) and aqueous calcium hydroxide produces water and aqueous calcium sulfate.

44. Challenge When benzoic acid (C_6H_5COOH) and magnesium hydroxide are mixed, water and magnesium benzoate are produced.

43. Mixing hydrosulfuric acid (H_2S) and aqueous calcium hydroxide produces water and aqueous calcium sulfate.

chemical equation:
$H_2S(aq) + 1\ Ca(OH)_2(aq) \rightarrow 2H_2O(l) + CaS(aq)$

complete ionic equation:
$2H^+(aq) + \cancel{S^{2-}}(aq) + \cancel{Ca^{2+}}(aq) + 2OH^-(aq) \rightarrow 2H_2O(l) + \cancel{Ca^{2+}}(aq) + \cancel{S^{2-}}(aq)$

net ionic equation: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

44. Challenge When benzoic acid (C_6H_5COOH) and magnesium hydroxide are mixed, water and magnesium benzoate are produced.

chemical equation: $2C_6H_5COOH(aq) + Mg(OH)_2(aq) \rightarrow Mg(C_6H_5COO)_2(aq) + 2H_2O(l)$

complete ionic equation: $\cancel{2C_6H_5COO^-(aq)} + 2H^+(aq) + \cancel{Mg^{2+}(aq)} + 2OH^-(aq) \rightarrow \cancel{2C_6H_5COO^-(aq)} + \cancel{Mg^{2+}(aq)} + 2H_2O(l)$

net ionic equation: $2H^+(aq) + 2OH^-(aq) \rightarrow 2H_2O(l)$

40. Mixing sulfuric acid (H_2SO_4) and aqueous potassium hydroxide produces water and aqueous potassium sulfate.

chemical equation:
$H_2SO_4(aq) + 2KOH(aq) \rightarrow 2H_2O(l) + K_2SO_4(aq)$

complete ionic equation:
$2H^+(aq) + \cancel{SO_4^{2-}}(aq) + \cancel{2K^+}(aq) + 2OH^-(aq) \rightarrow 2H_2O(l) + \cancel{2K^+}(aq) + \cancel{SO_4^{2-}}(aq)$

net ionic equation: $2H^+(aq) + 2OH^-(aq) \rightarrow 2H_2O(l)$ **or** $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

41. Mixing hydrochloric acid (HCl) and aqueous calcium hydroxide produces water and aqueous calcium chloride.

chemical equation:
$2HCl(aq) + Ca(OH)_2(aq) \rightarrow 2H_2O(l) + CaCl_2(aq)$

complete ionic equation:
$2H^+(aq) + \cancel{2Cl^-}(aq) + \cancel{Ca^{2+}}(aq) + 2OH^-(aq) \rightarrow 2H_2O(l) + \cancel{Ca^{2+}}(aq) + \cancel{2Cl^-}(aq)$

net ionic equation: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

. Mixing nitric acid (HNO_3) and aqueous ammonium hydroxide produces water and aqueous ammonium nitrate.

chemical equation:
$HNO_3(aq) + NH_4OH(aq) \rightarrow H_2O(l) + NH_4NO_3(aq)$

complete ionic equation:
$H^+(aq) + \cancel{NO^{3-}}(aq) + \cancel{NH_4^+}(aq) + OH^-(aq) \rightarrow H_2O(l) + \cancel{NH_4^+}(aq) + \cancel{NO_3^-}(aq)$

net ionic equation: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

CHAPTER 4 : CHEMICAL REACTION

SECTION 3 : ACTIONS IN AQUEOUS SOLUTIONS

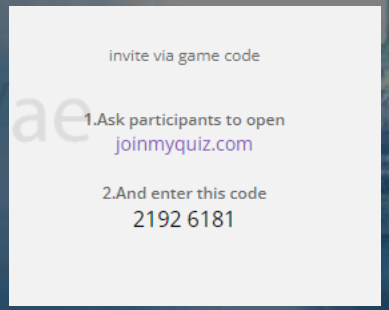
Key Words

- **Aqueous solution**
- **Precipitate**
- **Complete ionic equation**
- **Net ionic equation**
- **Spectator ions**
- **Double replacement**

ASSESMENT ON QUIZZEZ

Lesson : https://quizizz.com/join?gc=31199525

ASSESMENT : https://quizizz.com/join?gc=21926181



CHAPTER 5

THE MOLE

Question #	Learning Outcomes	References in the student book	
10	Demonstrate the concepts of Avogadro's number and Mole يوضح مفهومي عدد أفوجادرو والمول	Text book نص الكتاب	151

The mole The **mole,** abbreviated mol, is the SI base unit used to measure the amount of a substance. A mole is defined as the number of carbon atoms in exactly 12 g of pure carbon-12. Through years of experimentation, it has been established that a mole of anything contains 6.0221367×10^{23} representative particles. A representative particle is any kind of particle, such as an atom, a molecule, a formula unit, an electron, or an ion. If you write out Avogadro's number, it looks like this.

602,213,670,000,000,000,000,000

The number 6.0221367×10^{23} is called **Avogadro's number,** in honor of the Italian physicist and lawyer Amedeo Avogadro, who, in 1811, determined the volume of 1 mol of a gas. In this book, Avogadro's number is rounded to three significant figures, 6.02×10^{23}.

To count extremely small particles, such as atoms, Avogadro's number must be an enormous quantity. As you might imagine, Avogadro's number would not be convenient for measuring a quantity of marbles. Avogadro's number of marbles would cover the surface of Earth to a depth of more than six kilometers! **Figure 10.2,** however, shows that it is convenient to use the mole to measure amounts of substances. One-mole quantities of water, copper, and salt are shown, each with a different representative particle. The representative particle in a mole of water is the water molecule, the representative particle in a mole of copper is the copper atom, and the representative particle in a mole of sodium chloride is the NaCl formula unit.

LESSON REFRENCE AND ASSESMENT

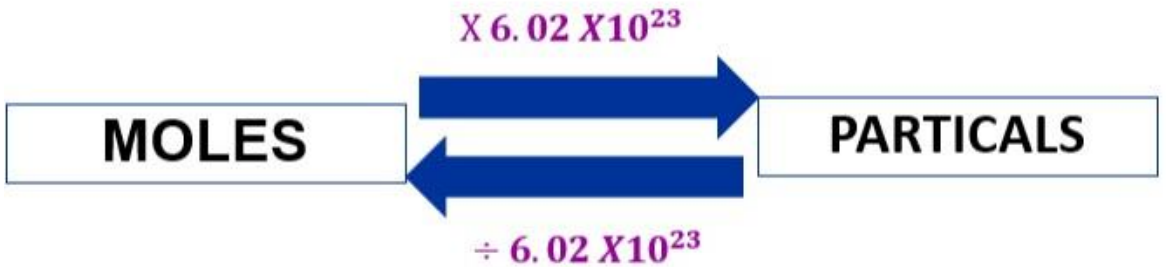
https://quizizz.com/join?gc=32170277

Question #	Learning Outcomes	References in the student book	
11	Describe the relations between Avogadro's number, the mole concept, mass and the molar mass of any given substance يصف العلاقات بين عدد أفوجادرو والمول والكتلة والكتلة الجزيئية لأية مادة	application questions أسئلة التطبيقات	153

PRACTICE Problems

Extra Practice Page 981 and glencoe.com

1. Zinc (Zn) is used to form a corrosion-inhibiting surface on galvanized steel. Determine the number of Zn atoms in 2.50 mol of Zn.
2. Calculate the number of molecules in 11.5 mol of water (H_2O).
3. Silver nitrate ($AgNO_3$) is used to make several different silver halides used in photographic films. How many formula units of $AgNO_3$ are there in 3.25 mol of $AgNO_3$?
4. **Challenge** Calculate the number of oxygen atoms in 5.0 mol of oxygen molecules. Oxygen is a diatomic molecule, O_2.



1. Zinc (Zn) is used to form a corrosion-inhibiting surface on galvanized steel. Determine the number of Zn atoms in 2.50 mol of Zn.

$$2.50 \text{ mol Zn} \times \frac{6.02 \times 10^{23} \text{ atoms Zn}}{1 \text{ mol Zn}}$$

$$= 1.51 \times 10^{24} \text{ atoms of Zn}$$

2. Calculate the number of molecules in 11.5 mol of water (H_2O).

$$11.5 \text{ mol } H_2O \times \frac{6.02 \times 10^{23} \text{ molecules } H_2O}{1 \text{ mol } H_2O}$$

$$= 6.92 \times 10^{24} \text{ molecules of } H_2O$$

3. Silver nitrate ($AgNO_3$) is used to make several different silver halides used in photographic films. How many formula units of $AgNO_3$ are there in 3.25 mol $AgNO_3$?

$$3.25 \text{ mol } AgNO_3 \times \frac{6.02 \times 10^{23} \text{ formula units } AgNO_3}{1 \text{ mol } AgNO_3}$$

$$= 1.96 \times 10^{24} \text{ formula units of } AgNO_3$$

4. Challenge Calculate the number of oxygen atoms in 5.0 mol of oxygen molecules. Oxygen is a diatomic molecule, O_2.

$$5.00 \text{ mol } O_2 \times \frac{6.02 \times 10^{23} \text{ molecules } O^2}{1 \text{ mol } O_2}$$

$$\times \frac{2 \text{ O atoms}}{\text{molecule } O_2} = 6.02 \times 10^{24} \text{ atoms O}$$

Question #	Learning Outcomes	References in the student book
12	Describe the relations between Avogadro's number, the mole concept, mass and the molar mass of any given substance يصف العلاقات بين عدد أفوجادرو والمول والكتلة والكتلة الجزيئية لأية مادة	Text book نص الكتاب 156

Molar Mass How does the mass of one atom relate to the mass of one mole of that atom? Recall that the mole is defined as the number of carbon-12 atoms in exactly 12 g of pure carbon-12. Thus, the mass of one mole of carbon-12 atoms is 12 g. Whether you are considering a single atom or Avogadro's number of atoms (a mole), the masses of all atoms are established relative to the mass of carbon-12. The mass in grams of one mole of any pure substance is called its **molar mass.**

The molar mass of any element is numerically equal to its atomic mass and has the units g/mol. As given on the periodic table, an atom of iron has an atomic mass of 55.845 amu. Thus, the molar mass of iron is 54.845 g/mol, and 1 mol (or 6.02×10^{23} atoms of iron) has a mass of 55.845 g. Note that by measuring 55.845 g of iron, you indirectly count out 6.02×10^{23} atoms of iron. **Figure 10.6** shows the relationship between molar mass and one mole of an element.

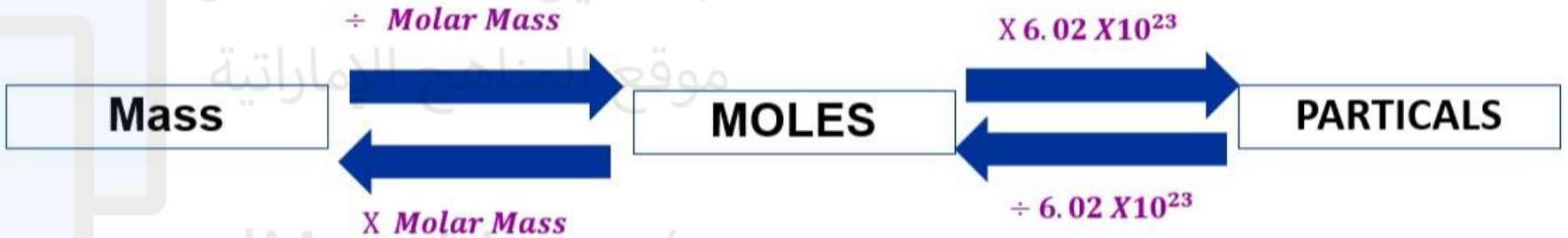
Figure 10.6 One mole of iron, represented by a bag of particles, contains Avogadro's number of atoms and has a mass equal to its atomic mass in grams.

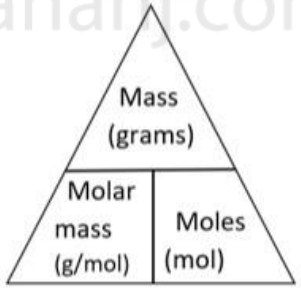
Apply *What is the mass of one mole of copper?*

Concepts in Motion

Interactive Figure To see an animation of molar mass, visit glencoe.com.

1 mol of iron = 6.02×10^{23} atoms of iron





LESSON REFRENCE AND ASSESMENT

https://quizizz.com/join?gc=32170277

Question #	Learning Outcomes	References in the student book
13	Perform stoichiometric calculations using the mole concept, mass, molar mass, number of particles, volume, pressure and concentration يجري الحسابات الكيميائية المبنية على مفهوم المول والكتلة والكتلة الجزيئية وعدد الجسيمات والحجم والضغط والتركيز	Example3+ application questions مثال3+ أسئلة التطبيقات 159

BOOK REFERENCE- Example 3

EXAMPLE Problem 10.2

Math Handbook
Rounding
page 952

Mole-to-Mass Conversion Chromium (Cr), a transition element, is a component of chrome plating. Chrome plating is used on metals and in steel alloys to control corrosion. Calculate the mass in grams of 0.0450 mol Cr.

1 Analyze the Problem

You are given the number of moles of chromium and must convert it to an equivalent mass using the molar mass of chromium from the periodic table. Because the sample is less than one-tenth of a mole, the answer should be less than one-tenth of the molar mass.

Known
number of moles = 0.0450 mol Cr
molar mass Cr = 52.00 g/mol Cr

Unknown
mass Cr = ? g

2 Solve for the Unknown

Use a conversion factor—the molar mass—that relates grams of chromium to moles of chromium. Write the conversion factor with moles of chromium in the denominator and grams of chromium in the numerator. Substitute the known values into the equation and solve.

$$\text{moles Cr} \times \frac{\text{grams Cr}}{1\ \text{mol Cr}} = \text{grams Cr}$$

Apply the conversion factor.

$$0.0450\ \cancel{\text{mol Cr}} \times \frac{52.00\ \text{g Cr}}{1\ \cancel{\text{mol Cr}}} = 2.34\ \text{g Cr}$$

Substitute 0.450 mol for moles Cr and 52.00 g/mol for molar mass of Cr. Multiply and divide number and units.

3 Evaluate the Answer

The known number of moles of chromium has the smallest number of significant figures, three, so the answer is correctly stated with three digits. The answer is less than one-tenth the mass of 1 mol, as predicted, and is in grams, a mass unit.

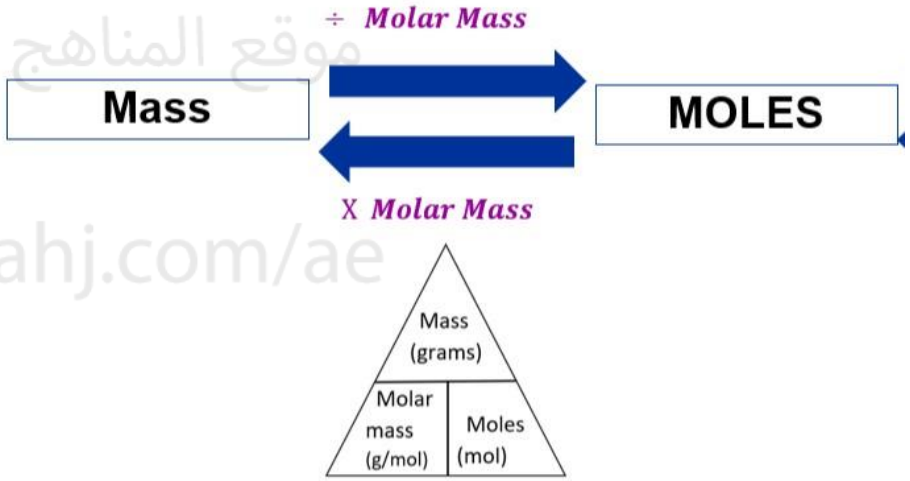
Application Questions

PRACTICE Problems

Extra Practice Page 981 and glencoe.com

15. Determine the mass in grams of each of the following.
- **a.** 3.57 mol Al
- **b.** 42.6 mol Si

16. Challenge Convert each given quantity in scientific notation to mass in grams expressed in scientific notation.
- **a.** 3.45×10^2 mol Co
- **b.** 2.45×10^{-2} mol Zn



15. Determine the mass in grams of each of the following.

a. 3.57 mol Al

$$3.57\ \cancel{\text{mol Al}} \times \frac{26.98\ \text{g Al}}{1\ \cancel{\text{mol Al}}} = 96.3\ \text{g Al}$$

b. 42.6 mol Si

$$42.6\ \cancel{\text{mol Si}} \times \frac{28.09\ \text{g Si}}{1\ \cancel{\text{mol Si}}} = 1.20 \times 10^3\ \text{g Si}$$

16. Challenge Convert each given quantity in scientific notation to mass in grams expressed in scientific notation.

a. 3.45×10^2 mol Co

$$3.45 \times 10^2\ \cancel{\text{mol Co}} \times \frac{58.93\ \text{g Co}}{1\ \cancel{\text{mol Co}}}$$

$$= 2.03 \times 10^4\ \text{g Co}$$

Question #	Learning Outcomes	References in the student book	
14	Perform stoichiometric calculations using the mole concept, mass, molar mass, number of particles, volume, pressure and concentration يجري الحسابات الكيميائية المبنية على مفهوم المول والكتلة والكتلة الجزيئية وعدد الجسيمات والحجم والضغط والتركيز	Example6 مثال6	164

BOOK REFERENCE- Example 6

EXAMPLE Problem 10.6

Math Handbook
Dimensional Analysis
page 956

Mole Relationships from a Chemical Formula Aluminum oxide (Al_2O_3), often called alumina, is the principal raw material for the production of aluminum (Al). Alumina occurs in the minerals corundum and bauxite. Determine the moles of aluminum ions (Al^{3+}) in 1.25 mol of Al_2O_3.

1 Analyze the Problem

You are given the number of moles of Al_2O_3 and must determine the number of moles of Al^{3+} ions. Use a conversion factor based on the chemical formula that relates moles of Al^{3+} ions to moles of Al_2O_3. Every mole of Al_2O_3 contains 2 mol of Al^{3+} ions. Thus, the answer should be two times the number of moles of Al_2O_3.

Known
number of moles = 1.25 mol Al_2O_3

Unknown
number of moles = ? mol Al^{3+} ions

2 Solve for the Unknown

Use the relationship that 1 mol of Al_2O_3 contains 2 mol of Al^{3+} ions to write a conversion factor.

$$\frac{2 \text{ mol } Al^{3+} \text{ ions}}{1 \text{ mol } Al_2O_3}$$

Create a conversion factor relating moles of Al^{3+} ions to moles of Al_2O_3.

To convert the known number of moles of Al_2O_3 to moles of Al^{3+} ions, multiply by the ions-to-moles conversion factor.

$$\text{moles } Al_2O_3 \times \frac{2 \text{ mol } Al^{3+} \text{ ions}}{1 \text{ mol } Al_2O_3} = \textbf{moles } Al^{3+} \textbf{ ions}$$

Apply the conversion factor.

$$1.25 \cancel{\text{ mol } Al_2O_3} \times \frac{2 \text{ mol } Al^{3+} \text{ ions}}{1 \cancel{\text{ mol } Al_2O_3}} = \textbf{2.50 mol } Al^{3+} \textbf{ ions}$$

Substitute moles Al_2O_3 = 1.25 mol Al_2O_3 and solve.

3 Evaluate the Answer

Because the conversion factor is a ratio of whole numbers, the number of significant digits is based on the moles of Al_2O_3. Therefore, the answer is expressed correctly with three significant figures. As predicted, the answer is twice the number of moles of Al_2O_3.

Question #	Learning Outcomes	References in the student book	
15	Perform stoichiometric calculations using the mole concept, mass, molar mass, number of particles, volume, pressure and concentration يجرى الحسابات الكيميائية المبنية على مفهوم المول والكتلة والكتلة الجزيئية وعدد الجسيمات والحجم والضغط والتركيز	application questions أسئلة التطبيقات	165

Application Questions

تطبيقات

29. Zinc chloride ($ZnCl_2$) is used in soldering flux, an alloy used to join two metals together. Determine the moles of Cl^- ions in 2.50 mol $ZnCl_2$.

Zn = 1 x 2.5o = 2.50 mol

CL = 2X2.50= 5.00mol

31. Iron(III) sulfate[$Fe_2(SO_4)_3$] is sometimes used in the water purification process. Determine the number of moles of sulfate ions present in 3.00 mol of $Fe_2(SO_4)_3$.

Fe=2x3=6mol

S=3x3=9mol

O=12x3=36mol

30. Plants and animals depend on glucose ($C_6H_{12}O_6$) as an energy source. Calculate the number of moles of each element in 1.25 mol $C_6H_{12}O_6$.

C= 6x1.25= 7.5mol

H= 12x1.25= 15mol

O=6x1.25= 7.5mol

32. How many moles of oxygen atoms are present in 5.00 mol of diphosphorus pentoxide (P_2O_5)?

O = 5X5.00 = 25mol

33. Challenge Calculate the number of moles of hydrogen atoms in 1.15×10^1 mol of water. Express the answer in scientific notation.

H2O

H= $2X1.15X10^1 = 2.3X10^1$ mol

O=$1X1.15X10^1=1.15X10^1$ mol

Question #	Learning Outcomes	References in the student book	
16	Perform stoichiometric calculations using the mole concept, mass, molar mass, number of particles, volume, pressure and concentration يجري الحسابات الكيميائية المبنية على مفهوم المول والكتلة والكتلة الجزيئية وعدد الجسيمات والحجم والضغط والتركيز	Example7+ application questions مثال7+ أسئلة التطبيقات	166

BOOK REFERENCE- Example 7

EXAMPLE Problem 10.7

Mole-to-Mass Conversion for Compounds The characteristic odor of garlic is due to allyl sulfide [$(C_3H_5)_2S$]. What is the mass of 2.50 mol of $(C_3H_5)_2S$?

Math Handbook
Calculations with Significant Figures
pages 952–953

1 Analyze the Problem

You are given 2.50 mol of $(C_3H_5)_2S$ and must convert the moles to mass using the molar mass as a conversion factor. The molar mass is the sum of the molar masses of all the elements in $(C_3H_5)_2S$.

Known
number of moles = 2.50 mol $(C_3H_5)_2S$

Unknown
molar mass = ? g/mol $(C_3H_5)_2S$
mass = ? g $(C_3H_5)_2S$

2 Solve for the Unknown

Calculate the molar mass of $(C_3H_5)_2S$.

$$1 \text{ mol S} \times \frac{32.07 \text{ g S}}{1 \text{ mol S}} = 32.07 \text{ g S}$$ Multiply the moles of S in the compound by the molar mass of S.

$$6 \text{ mol C} \times \frac{12.01 \text{ g C}}{1 \text{ mol C}} = 72.06 \text{ g C}$$ Multiply the moles of C in the compound by the molar mass of C.

$$10 \text{ mol H} \times \frac{1.008 \text{ g H}}{1 \text{ mol H}} = 10.08 \text{ g H}$$ Multiply the moles of H in the compound by the molar mass of H.

molar mass = (32.07 g + 72.06 g + 10.08 g) = **114.21 g/mol $(C_3H_5)_2S$** Total the mass values.

Use a conversion factor—the molar mass—that relates grams to moles.

$$\text{moles } (C_3H_5)_2S \times \frac{\text{grams } (C_3H_5)_2S}{1 \text{ mol } (C_3H_5)_2S} = \textbf{mass } (C_3H_5)_2S$$ Apply the conversion factor.

$$2.50 \text{ mol } (C_3H_5)_2S \times \frac{114.21 \text{ g } (C_3H_5)_2S}{1 \text{ mol } (C_3H_5)_2S} = \textbf{286 g } (C_3H_5)_2S$$ Substitute moles $(C_3H_5)_2S$ = 2.5 mol, molar mass $(C_3H_5)_2S$ = 114.21 g/mol, and solve.

LESSON REFRENCE AND ASSESMENT

https://quizizz.com/join?gc=32170277

Question #	Learning Outcomes	References in the student book	
16	Perform stoichiometric calculations using the mole concept, mass, molar mass, number of particles, volume, pressure and concentration يجري الحسابات الكيميائية المبنية على مفهوم المول والكتلة والكتلة الجزيئية وعدد الجسيمات والحجم والضغط والتركيز	Example7+ application questions مثال7+ أسئلة التطبيقات	166

Application Questions

PRACTICE Problems

Extra Practice Pages 981–982 and glencoe.com

37. The United States chemical industry produces more sulfuric acid (H_2SO_4), in terms of mass, than any other chemical. What is the mass of 3.25 mol of H_2SO_4?

38. What is the mass of 4.35×10^{-2} mol of zinc chloride ($ZnCl_2$)?

39. Challenge Write the chemical formula for potassium permanganate, and then calculate the mass in grams of 2.55 mol of the compound.

37. The United States chemical industry produces more sulfuric acid (H_2SO_4) in terms of mass, than any other chemical. What is the mass of 3.25 mol of H_2SO_4?

Step 1: Find the molar mass of H_2SO_4.

$$2 \text{ mol H} \times \frac{1.008 \text{ g H}}{1 \text{ mol H}} = 2.016 \text{ g H}$$

$$1 \text{ mol S} \times \frac{32.07 \text{ g S}}{1 \text{ mol S}} = 32.07 \text{ g S}$$

$$4 \text{ mol O} \times \frac{16.00 \text{ g O}}{1 \text{ mol O}} = 64.00 \text{ g O}$$

molar mass H_2SO_4 = 98.09 g/mol

Step 2: Make mole → mass conversion.

$$3.25 \text{ mol } H_2SO_4 \times \frac{98.09 \text{ g } H_2SO_4}{1 \text{ mol } H_2SO_4} = 319 \text{ g } H_2SO_4$$

38. What is the mass of 4.35×10^{-2} moles of zinc chloride ($ZnCl_2$)?

Step 1: Find the molar mass of $ZnCl_2$.

$$1 \text{ mol Zn} \times \frac{65.38 \text{ g Zn}}{1 \text{ mol Zn}} = 65.38 \text{ g Zn}$$

$$2 \text{ mol Cl} \times \frac{35.45 \text{ g Cl}}{1 \text{ mol Cl}} = 70.90 \text{ g Cl}$$

molar mass $ZnCl_2$ = 136.28 g/mol

Step 2: Make mole → mass conversion.

$$4.35 \times 10^{-2} \text{ mol } ZnCl_2 \times \frac{136.28 \text{ g } ZnCl_2}{1 \text{ mol } ZnCl_2}$$

$$= 5.93 \text{ g } ZnCl_2$$

39. Challenge Write the chemical formula for potassium permanganate, and then calculate the mass in grams of 2.55 mol of the compound.

Potassium permanganate has a formula of $KMnO_4$.

Step 1: Find the molar mass of $KMnO_4$.

$$1 \text{ mol K} \times \frac{39.10 \text{ g K}}{1 \text{ mol K}} = 39.10 \text{ g K}$$

$$1 \text{ mol Mn} \times \frac{54.94 \text{ g Mn}}{1 \text{ mol Mn}} = 54.94 \text{ g Mn}$$

$$4 \text{ mol O} \times \frac{16.00 \text{ g O}}{1 \text{ mol O}} = 64.00 \text{ g O}$$

molar mass $KMnO_4$ = 158.04 g/mol

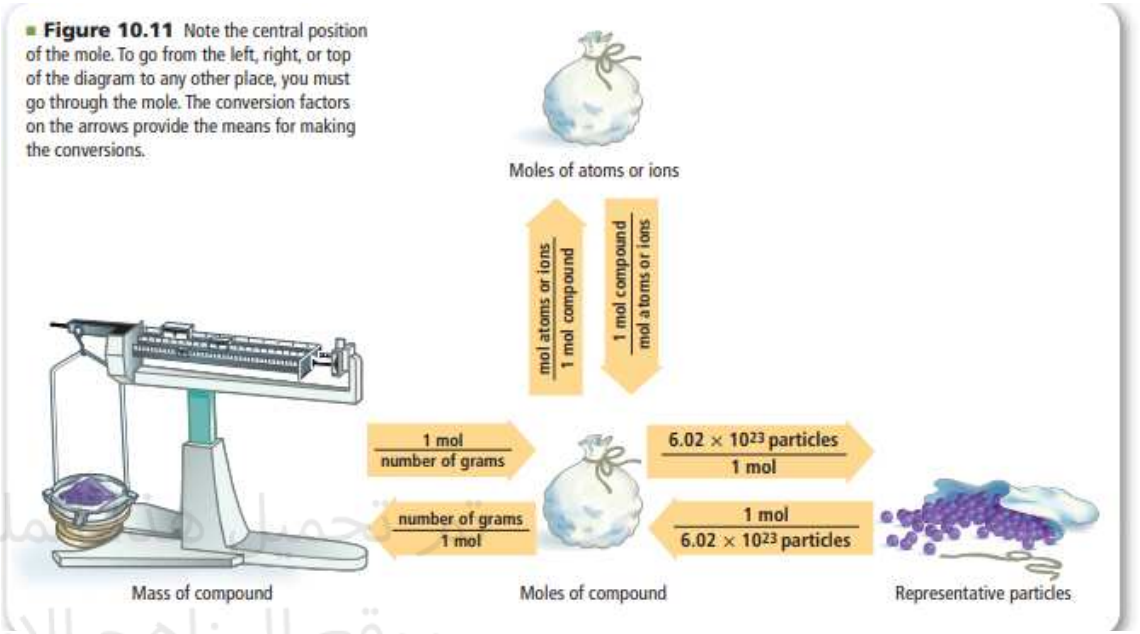
Step 2: Make mole → mass conversion.

$$2.55 \text{ mol } KMnO_4 \times \frac{158.04 \text{ g } KmnO_4}{1 \text{ mol } KmnO_4}$$

$$= 403 \text{ g } KMnO_4$$

Question #	Learning Outcomes	References in the student book	
17	Describe the relations between Avogadro's number, the mole concept, mass and the molar mass of any given substance يصف العلاقات بين عدد أفوجادرو والمول والكتلة والكتلة الجزيئية لأية مادة	Fiqure11 الشكل 11	170

BOOK REFERENCE



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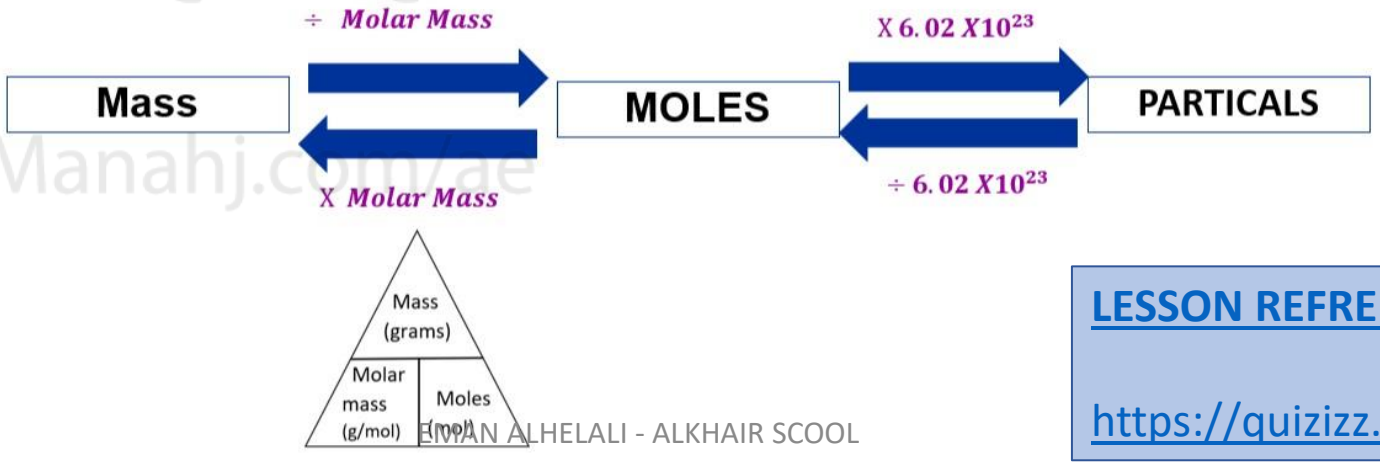

LESSON REFRENCE AND ASSESMENT

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Question #	Learning Outcomes	References in the student book	
18	Define the empirical and molecular formulas explaining how to apply it to the ionic and molecular compounds يحدد الصيغ الأولية والصيغ الجزيئية لعدة مركبات كيميائية مع وجود الكتل الجزيئية والنسب المئوية للتركيب أو أية بيانات أخرى	Example10+ application questions مثال10+ أسئلة التطبيقات	173-174

Percentage Composition

BOOK REFERENCE- Example 10

EXAMPLE Problem 10.10

Math Handbook
Percents
page 965

Calculating Percent Composition Sodium hydrogen carbonate ($NaHCO_3$), also called baking soda, is an active ingredient in some antacids used for the relief of indigestion. Determine the percent composition of $NaHCO_3$.

1 Analyze the Problem

You are given only the chemical formula. Assume you have 1 mol of $NaHCO_3$. Calculate the molar mass and the mass of each element in 1 mol to determine the percent by mass of each element in the compound. The sum of all percents should be 100, although your answer might vary slightly due to rounding.

Known
formula = $NaHCO_3$

Unknown
percent Na = ?
percent H = ?
percent C = ?
percent O = ?

2 Solve for the Unknown

Determine the molar mass of $NaHCO_3$ and each element's contribution.

$1 \text{ mol Na} \times \frac{22.99 \text{ g Na}}{1 \text{ mol Na}} = 22.99 \text{ g Na}$ — Multiply the molar mass of Na by the number of Na atoms in the compound.

$1 \text{ mol H} \times \frac{1.008 \text{ g H}}{1 \text{ mol H}} = 1.008 \text{ g H}$ — Multiply the molar mass of H by the number of H atoms in the compound.

$1 \text{ mol C} \times \frac{12.01 \text{ g C}}{1 \text{ mol C}} = 12.01 \text{ g C}$ — Multiply the molar mass of C by the number of C atoms in the compound.

$3 \text{ mol O} \times \frac{16.00 \text{ g O}}{1 \text{ mol O}} = 48.00 \text{ g O}$ — Multiply the molar mass of O by the number of O atoms in the compound.

molar mass = (22.99 g + 1.008 g + 12.01 g + 48.00 g) — Total the mass values.
= 84.01 g/mol $NaHCO_3$

Use the percent by mass equation.

$\%\text{ mass element} = \frac{\text{mass of element in 1 mol of compound}}{\text{molar mass of compound}} \times 100$ — State the equation.

$\text{percent Na} = \frac{22.99 \text{ g/mol}}{84.01 \text{ g/mol}} \times 100 = \mathbf{27.37\% \text{ Na}}$ — Substitute mass of Na in 1 mol compound = 22.99 g/mol and molar mass $NaHCO_3$ = 84.01 g/mol. Calculate % Na.

$\text{percent H} = \frac{1.008 \text{ g/mol}}{84.01 \text{ g/mol}} \times 100 = \mathbf{1.200\% \text{ H}}$ — Substitute mass of H in 1 mol compound = 1.0089 g/mol and molar mass $NaHCO_3$ = 84.01 g/mol. Calculate % H.

$\text{percent C} = \frac{12.01 \text{ g/mol}}{84.01 \text{ g/mol}} \times 100 = \mathbf{14.30\% \text{ C}}$ — Substitute mass of C in 1 mol compound = 12.01 g/mol and molar mass $NaHCO_3$ = 84.01 g/mol. Calculate % C.

$\text{percent O} = \frac{48.00 \text{ g/mol}}{84.01 \text{ g/mol}} \times 100 = \mathbf{57.14\% \text{ O}}$ — Substitute mass of O in 1 mol compound = 48.00 g/mol and molar mass $NaHCO_3$ = 84.01 g/mol. Calculate % O.

$NaHCO_3$ is 27.37% Na, 1.200% H, 14.30% C, and 57.14% O.

LESSON REFRENCE AND ASSESMENT

https://quizizz.com/join?gc=32170277

Question #	Learning Outcomes	References in the student book	
18	Define the empirical and molecular formulas explaining how to apply it to the ionic and molecular compounds يحدد الصيغ الأولية والصيغ الجزيئية لعدة مركبات كيميائية مع وجود الكتل الجزيئية والنسب المئوية للتركيب أو أية بيانات أخرى	Example10+ application questions مثال10+ أسئلة التطبيقات	173-174

BOOK REFERENCE- Example 10

PRACTICE Problems Extra Practice Page 982 and glencoe.com

54. What is the percent composition of phosphoric acid (H_3PO_4)?

55. Which has the larger percent by mass of sulfur, H_2SO_3 or $H_2S_2O_8$?

56. Calcium chloride ($CaCl_2$) is sometimes used as a de-icer. Calculate the percent by mass of each element in $CaCl_2$.

57. Challenge Sodium sulfate is used in the manufacture of detergents.

a. Identify each of the component elements of sodium sulfate, and write the compound's chemical formula.

b. Identify the compound as ionic or covalent.

c. Calculate the percent by mass of each element in sodium sulfate.

54. What is the percent composition of phosphoric acid (H_3PO_4)?

الكتلة المولية للمركب H3PO4=(3X1)+(1X31)+(4X16)=98g\mol

$$H = \frac{3X1}{98} \quad X100 \quad = 3.06\%$$

$$P = \frac{1X31}{98} \quad X\ 100 \quad = 31.63\%$$

$$O = \frac{4X16}{98} \quad X100 \quad = 65.31\%$$

55. Which has the larger percent by mass of sulfur, H_2SO_3 or $H_2S_2O_8$?

لكتلة المولية = (2X1)+(2X32)+(8X16)=194g\mol

$$S = \frac{2X32}{194} \quad X100 \quad = \quad 32.99\%$$

H_2SO_3

لكتلة المولية = (2x1)+(1x32)+(3x16)=82g\mol

$$S = \frac{1X32}{82} \quad X\ 100 \quad = \quad 39.02\%$$

56. Calcium chloride ($CaCl_2$) is sometimes used as a de-icer. Calculate the percent by mass of each element in $CaCl_2$.

Steps 1 and 2: Assume 1 mole; calculate molar mass of $CaCl_2$.

$$1\ \cancel{mol}\ Ca \times \frac{40.08\ g\ Ca}{1\ \cancel{mol}\ Ca} = 40.08\ g\ Ca$$

$$2\ \cancel{mol}\ Cl \times \frac{35.45\ g\ Cl}{1\ \cancel{mol}\ Cl} = 70.90\ g\ Cl$$

molar mass $CaCl_2$ = 110.98 g/mol

Question #	Learning Outcomes	References in the student book	
23	Define the empirical and molecular formulas explaining how to apply it to the ionic and molecular compounds يحدد الصيغ الأولية والصيغ الجزيئية لعدة مركبات كيميائية مع وجود الكتل الجزيئية والنسب المئوية للتركيب أو أية بيانات أخرى	Text book نص الكتاب	174

BOOK REFERENCE

Empirical Formula

When a compound's percent composition is known, its formula can be calculated. First, determine the smallest whole-number ratio of the moles of the elements in the compound. This ratio gives the subscripts in the empirical formula. The **empirical formula** for a compound is the formula with the smallest whole-number mole ratio of the elements. The empirical formula might or might not be the same as the actual molecular formula. If the two formulas are different, the molecular formula will always be a simple multiple of the empirical formula. The empirical formula for hydrogen peroxide is HO; the molecular formula is H_2O_2. In both formulas, the ratio of oxygen to hydrogen is 1:1.

Percent composition or masses of the elements in a given mass of compound can be used to determine the formula for the compound. If percent composition is given, assume the total mass of the compound is 100.00 g and that the percent by mass of each element is equal to the mass of that element in grams. This can be seen in **Figure 10.13,** where 100.00 g of the 40.05% S and 59.95% O compound contains 40.05 g of S and 59.95 g of O. The mass of each element is then converted to moles.

$$40.05 \text{ g} \cancel{\text{S}} \times \frac{1 \text{ mol S}}{32.07 \text{ g} \cancel{\text{S}}} = 1.249 \text{ mol S}$$

$$59.95 \text{ g} \cancel{\text{O}} \times \frac{1 \text{ mol O}}{16.00 \text{ g} \cancel{\text{O}}} = 3.747 \text{ mol O}$$

Thus, the mole ratio of S atoms to O atoms in the oxide is 1.249:3.747.

When the values in a mole ratio are not whole numbers, they cannot be used as subscripts in a chemical formula. You can convert the ratio to whole numbers by recognizing that the element with the smallest number of moles might have the smallest subscript possible, 1. To make the mole value of sulfur equal to 1, divide both mole values by the moles of sulfur (1.249). This does not change the ratio between the two elements because both are divided by the same number.

$$\frac{1.249 \text{ mol S}}{1.249} = 1 \text{ mol S} \qquad \frac{3.747 \text{ mol O}}{1.249} = 3 \text{ mol O}$$

The simplest whole-number mole ratio of S to O is 1:3. Thus, the empirical formula is SO_3. Sometimes, dividing by the smallest mole value does not yield whole numbers. In such cases, each mole value must then be multiplied by the smallest factor that will make it a whole number. This is shown in Example Problem 10.11.

LESSON REFRENCE AND ASSESMENT

https://quizizz.com/join?gc=32170277

Question #	Learning Outcomes	References in the student book
19	Define the empirical and molecular formulas explaining how to apply it to the ionic and molecular compounds يحدد الصيغ الأولية والصيغ الجزيئية لعدة مركبات كيميائية مع وجود الكتل الجزيئية والنسب المئوية للتركيب أو أية بيانات أخرى	Example11+ application questions مثال11+ أسئلة التطبيقات 175

Empirical Formula

BOOK REFERENCE- Example 11

EXAMPLE Problem 10.11

Empirical Formula from Percent Composition Methyl acetate is a solvent commonly used in some paints, inks, and adhesives. Determine the empirical formula for methyl acetate, which has the following chemical analysis: 48.64% carbon, 8.16% hydrogen, and 43.20% oxygen.

Math Handbook
Ratios
page 964

1 Analyze the Problem

You are given the percent composition of methyl acetate and must find the empirical formula. Because you can assume that each percent by mass represents the mass of the element in a 100.00-g sample, the percent sign can be replaced with the unit grams. Then, convert from grams to moles and find the smallest whole-number ratio of moles of the elements.

Known
percent by mass C = 48.64% C
percent by mass H = 8.16% H
percent by mass O = 43.20% O

Unknown
empirical formula = ?

2 Solve for the Unknown

Convert each mass to moles using a conversion factor—the inverse of the molar mass—that relates moles to grams.

$48.64\ \cancel{g\ C} \times \frac{1\ mol\ C}{12.01\ \cancel{g\ C}} = 4.050\ mol\ C$ — Substitute mass C = 48.64 g, inverse molar mass C = 1 mol/12.01 g, and calculate moles of C.

$8.16\ \cancel{g\ H} \times \frac{1\ mol\ H}{1.008\ \cancel{g\ H}} = 8.10\ mol\ H$ — Substitute mass H = 8.16 g, inverse molar mass H = 1 mol/1.008 g, and calculate moles of H.

$43.20\ \cancel{g\ O} \times \frac{1\ mol\ O}{16.00\ \cancel{g\ O}} = 2.700\ mol\ O$ — Substitute mass O = 43.20 g, inverse molar mass O = 1 mol/16.00 g, and calculate moles of O.

Methyl acetate has a mole ratio of (4.050 mol C):(8.10 mol H):(2.700 mol O). Next, calculate the simplest ratio of moles of elements by dividing the moles of each element by the smallest value in the calculated mole ratio.

$\frac{4.050\ mol\ C}{2.700} = 1.500\ mol\ C = 1.5\ mol\ C$ — Divide moles of C by 2.700.

$\frac{8.10\ mol\ H}{2.700} = 3.00\ mol\ H = 3\ mol\ H$ — Divide moles of H by 2.700.

$\frac{2.700\ mol\ O}{2.700} = 1.000\ mol\ O = 1\ mol\ O$ — Divide moles of O by 2.700.

The simplest mole ratio is (1.5 mol C):(3 mol H):(1 mol O). Multiply each number in the ratio by the smallest number—in this case 2—that yields a ratio of whole numbers.

$2 \times 1.5\ mol\ C = 3\ mol\ C$ — Multiply moles of C by 2 to obtain a whole number.

$2 \times 3\ mol\ H = 6\ mol\ H$ — Multiply moles of H by 2 to obtain a whole number.

$2 \times 1\ mol\ O = 2\ mol\ O$ — Multiply moles of O by 2 to obtain a whole number.

The simplest whole-number ratio of atoms is (3 atoms C):(6 atoms H):(2 atoms O). Thus, the empirical formula of methyl acetate is $C_3H_6O_2$.

TO SOLVE THIS QUESTION INCLUDE THE FOLLOWING STEPS

ATOMS (MOLAR MASS OF EACH ELEMENT)

MOLE
(mass / molar mass)

RATIO

Write empirical formula

ANOTHER EXAMPLE NEXT SLIDE

Determine the Empirical Formula from percentage

A compound contains 65.44% Carbon, 5.49% Hydrogen and 29.07% Oxygen. Find its Empirical Formula.

	C	H	O
1) ATOMS	C = 12 g	H = 1 g	O = 16 g
2) MOLES	$\frac{65.44}{12}$	$\frac{5.49}{1}$	$\frac{29.07}{16}$
3) RATIO	$\frac{5.45}{1.82} = 2.99 = 3$	$\frac{5.49}{1.82} = 3.016 = 3$	$\frac{1.82}{1.82} = 1 = 1$

C_3H_3O

Question #	Learning Outcomes	References in the student book
19	Define the empirical and molecular formulas explaining how to apply it to the ionic and molecular compounds يحدد الصيغ الأولية والصيغ الجزيئية لعدة مركبات كيميائية مع وجود الكتل الجزيئية والنسب المئوية للتركيب أو أية بيانات أخرى	Example11+ application questions مثال11+ أسئلة التطبيقات 175

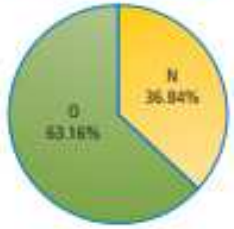
PRACTICE Problems — Extra Practice Page 982 and glencoe.com

58. The circle graph at the right gives the percent composition for a blue solid. What is the empirical formula for this solid?

59. Determine the empirical formula for a compound that contains 35.98% aluminum and 64.02% sulfur.

60. Propane is a hydrocarbon, a compound composed only of carbon and hydrogen. It is 81.82% carbon and 18.18% hydrogen. What is the empirical formula?

61. Challenge Aspirin is the world's most-often used medication. The chemical analysis of aspirin indicates that the molecule is 60.00% carbon, 4.44% hydrogen, and 35.56% oxygen. Determine the empirical formula for aspirin.



TO SOLVE THIS QUESTION INCLUDE THE FOLLOWING STEPS

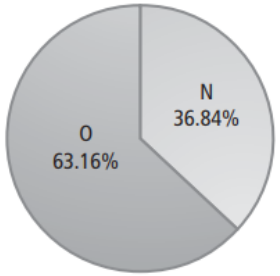
ATOMS (MOLAR MASS OF EACH ELEMENT)

MOLE
(mass / molar mass)

RATIO

Write empirical formula

58. The circle graph at the right gives the percent composition for a blue solid. What is the empirical formula for this solid?



Step 1: Assume 100 g sample; calculate moles of each element.

$$36.84\ \cancel{g\ N} \times \frac{1\ \text{mol N}}{14.01\ \cancel{g\ N}} = 2.630\ \text{mol N}$$

$$63.16\ \cancel{g\ O} \times \frac{1\ \text{mol O}}{16.00\ \cancel{g\ O}} = 3.948\ \text{mol O}$$

Step 2: Calculate mole ratios.

$$\frac{2.630\ \text{mol N}}{2.630\ \text{mol N}} = \frac{1.000\ \text{mol N}}{1.000\ \text{mol N}} = \frac{1\ \text{mol N}}{1\ \text{mol N}}$$

$$\frac{3.948\ \text{mol O}}{2.630\ \text{mol O}} = \frac{1.500\ \text{mol O}}{1.000\ \text{mol N}} = \frac{1.5\ \text{mol O}}{1\ \text{mol N}}$$

The simplest ratio is 1 mol N: 1.5 mol O.

Step 3: Convert decimal fraction to whole number.

In this case, multiply by 2 because 1.5 × 2 = 3. Therefore, the empirical formula is N_2O_3.

59. Determine the empirical formula for a compound that contains 35.98% aluminum and 64.02% sulfur.

Step 1: Assume 100 g sample; calculate moles of each element.

$$35.98\ \cancel{g\ Al} \times \frac{1\ \text{mol Al}}{26.98\ \cancel{g\ Al}} = 1.334\ \text{mol Al}$$

$$64.02\ \cancel{g\ S} \times \frac{1\ \text{mol S}}{32.06\ \cancel{g\ S}} = 1.996\ \text{mol S}$$

Step 2: Calculate mole ratios.

$$\frac{1.334\ \text{mol Al}}{1.334\ \text{mol Al}} = \frac{1.000\ \text{mol Al}}{1.000\ \text{mol Al}} = \frac{1\ \text{mol Al}}{1\ \text{mol Al}}$$

$$\frac{1.996\ \text{mol S}}{1.334\ \text{mol Al}} = \frac{1.500\ \text{mol S}}{1.000\ \text{mol Al}} = \frac{1.5\ \text{mol S}}{1\ \text{mol Al}}$$

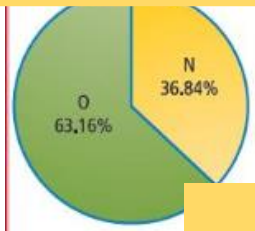
The simplest ratio is 1 mol Al: 1.5 mol S.

Step 3: Convert decimal fraction to whole number.

In this case, multiply by 2 because 1.5 × 2 = 3. Therefore, the empirical formula is Al_2S_3.

حل تفصيلي للتطبيقات

58. The circle graph at the right gives the percent composition for a blue solid. What is the empirical formula for this solid?



N= 14g\mol
O= 16g\mol

الخطوة الاولى : ايجاد عدد مولات كل عنصر

ملاحظة : النسبة المئوية بالكتلة = الكتلة

MOLE (mass / molar mass)

$N = \frac{\text{الكتلة}}{\text{الكتلة المولية}} = \frac{36.84}{14} = 2.63g$

MOLE (mass / molar mass)

$O = \frac{\text{الكتلة}}{\text{الكتلة المولية}} = \frac{63.16}{16} = 3.95g$

الخطوة الثانية:
كتابة العنصرين بالترتيب من اليسار الى اليمين
وبجانب كل عنصر عدد مولاته اسفل يمينه

N2.63 O 3.95

الخطوة الثالثة : القسمة على العدد الاقل لكل العناصر ويجب ان يكون الناتج عدد صحيح لو كان غير ذلك بعد القسمة ضرب كل المركب ب2 او3و 4 لتتغير القيم الى صحيحة

N2.63 / 2.63 O 3.95 / 2.63 ⇨ (N1 O1.5) X2

الصيغة الاولية N2O3

59. Determine the empirical formula for a compound that contains 35.98% aluminum and 64.02% sulfur.

Al =27g\mol \ S=32g\mol

MOLE (mass / molar mass)

$Al = \frac{\text{الكتلة}}{\text{الكتلة المولية}} = \frac{35.98}{27} = 1.34\ mol$

MOLE (mass / molar mass)

$S = \frac{\text{الكتلة}}{\text{الكتلة المولية}} = \frac{64.02}{32} = 2mol$

RATIO

Al 1.34/1.34 S 2/1.34 ⇨ Al 1 S 1.5 x2 ⇨ الصيغة الاولية Al2S3

60. Propane is a hydrocarbon, a compound composed only of carbon and hydrogen. It is 81.82% carbon and 18.18% hydrogen. What is the empirical formula?

C =12g\mol
H= 1g\mol

MOLE (mass / molar mass)

$C = \frac{\text{الكتلة}}{\text{الكتلة المولية}} = \frac{81.82}{12} = 6.81\text{mol}$

MOLE (mass / molar mass)

$H = \frac{\text{الكتلة}}{\text{الكتلة المولية}} = \frac{18.18}{1} = 18.18\ \text{mol}$

RATIO

$C\ \frac{6.81}{6.81}\quad H\ \frac{18.18}{6.81} \Rightarrow (C\ 1\quad H\ 2.7) \times 3 \Rightarrow C3\ H\ 8$

61. Challenge Aspirin is the world's most-often used medication. The chemical analysis of aspirin indicates that the molecule is 60.00% carbon, 4.44% hydrogen, and 35.56% oxygen. Determine the empirical formula for aspirin.

C =12g\mol
H= 1 g\mol

ايجاد الصيغة الاولية

ملاحظة : لايجاد الصيغة الجزيئية ايجاد الكتلة المولية للصيغة الاولية

MOLE (mass / molar mass)

$C = \frac{\text{الكتلة}}{\text{الكتلة المولية}} = \frac{49.98}{12} = 4.2\text{mol}$

الكتلة المولية $C2H5=(2X12)+(5X1) = 29\ g\mol$

ملاحظة 2 : ايجاد قيمة n

$n = \frac{\text{الكتلة المولية الفعلية(المجودة بالسؤال)}}{\text{الكتلة المولية للصيغة الاولية}}$

MOLE (mass / molar mass)

$H = \frac{\text{الكتلة}}{\text{الكتلة المولية}} = \frac{10.47}{1} = 10.47\ \text{mol}$

$n = \frac{58.12}{29} = 2 \Rightarrow (C2H5)Xn$

RATIO

$C\ \frac{4.2}{4.2}\quad H\ \frac{10.47}{4.2} \Rightarrow (C\ 1\quad H\ 2.5) \times 2 \rightarrow$ الصيغة الاولية C2H5

$(C2H5)X2=(C4H10)$ الصيغة الجزيئية

Question #	Learning Outcomes	References in the student book	
20	Demonstrate the relationship between the empirical formula and molecular formula for a chemical compound يبين العلاقة بين الصيغة الأولية والصيغة الجزيئية لمركب كيميائي	Text book نص الكتاب	176

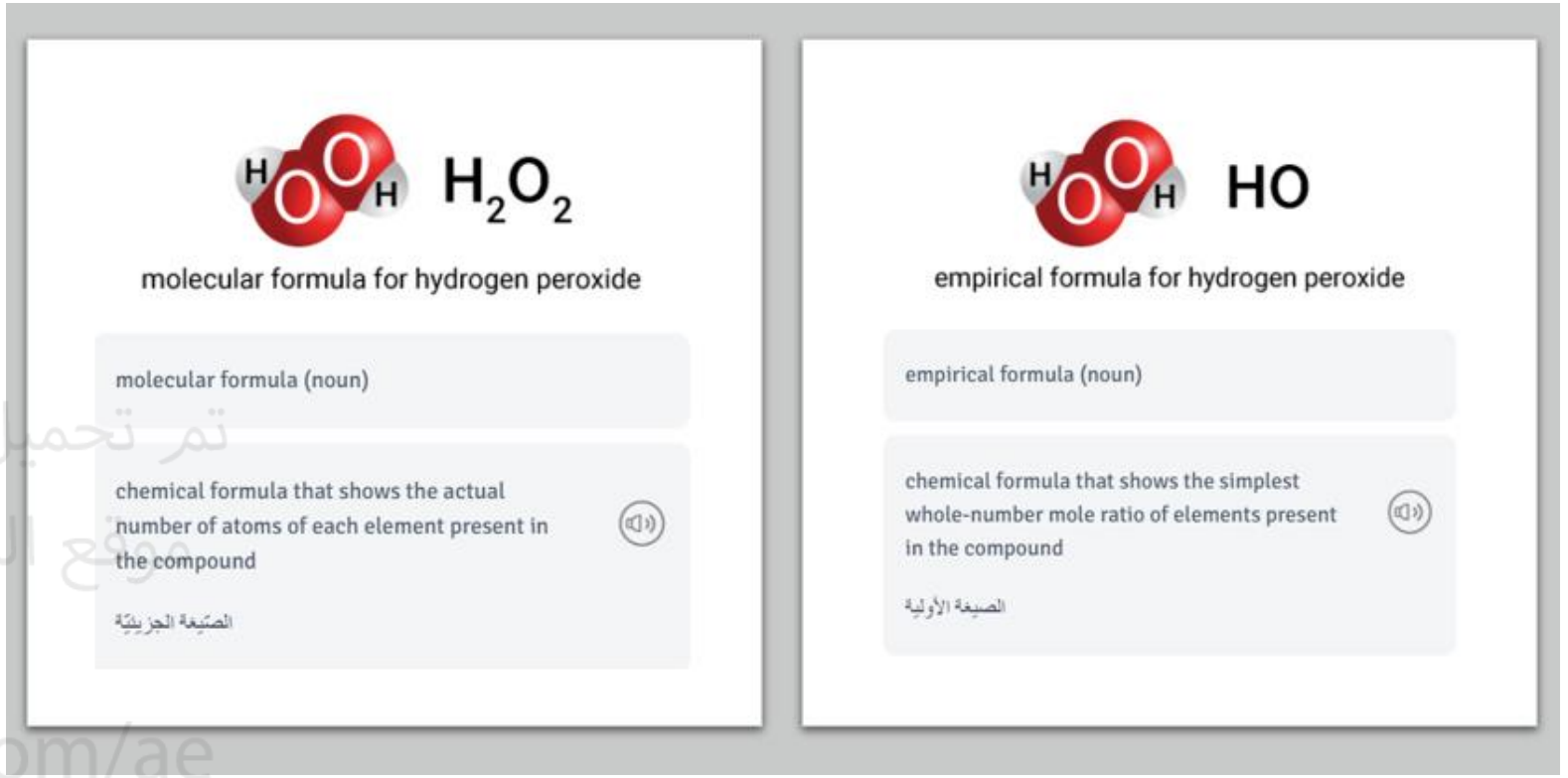
Molecular Formula

Would it surprise you to learn that substances with distinctly different properties can have the same percent composition and the same empirical formula? How is this possible? Remember that the subscripts in an empirical formula indicate the simplest whole-number ratio of moles of the elements in the compound. But the simplest ratio does not always indicate the actual ratio in the compound. To identify a new compound, a chemist determine the **molecular formula,** which specifies the actual number of atoms of each element in one molecule or formula unit of the substance. **Figure 10.14** shows an important use of the gas acetylene. It has the same percent composition and the same empirical formula (CH) as benzene, which is a liquid. Yet chemically and structurally, acetylene and benzene are very different.

To determine the molecular formula for a compound, the molar mass of the compound must be determined through experimentation and compared with the mass represented by the empirical formula. For example, the molar mass of acetylene is 26.04 g/mol, and the mass of the empirical formula (CH) is 13.02 g/mol. Dividing the actual molar mass by the mass of the empirical formula indicates that the molar mass of acetylene is two times the mass of the empirical formula.

$$\frac{\text{experimentally determined molar mass of acetylene}}{\text{mass of empirical formula}} = \frac{26.04\ \cancel{\text{g/mol}}}{13.02\ \cancel{\text{g/mol}}} = 2.000$$

Because the molar mass of acetylene is two times the mass represented by the empirical formula, the molecular formula of acetylene must contain twice the number of carbon and hydrogen atoms as represented by the empirical formula.



LESSON REFRENCE AND ASSESMENT

https://quizizz.com/join?gc=32170277

Question #	Learning Outcomes	References in the student book	
22	Explain the chain of chemical reactions that can occur in aqueous solutions يفسّر سلسلة التفاعلات الكيميائية التي يمكن أن تحدث في المحاليل المائية	Text book نص الكتاب	131

Ionic equations To show the details of reactions that involve ions in aqueous solutions, chemists use ionic equations. Ionic equations differ from chemical equations in that substances that are ions in solution are written as ions in the equation. Look again at the reaction between aqueous solutions of sodium hydroxide and copper(II) chloride. To write the ionic equation for this reaction, you must show the reactants, $NaOH(aq)$ and $CuCl_2(aq)$, and the product, $NaCl(aq)$, as ions.

$$2Na^+(aq) + 2OH^-(aq) + Cu^{2+}(aq) + 2Cl^-(aq) \rightarrow 2Na^+(aq) + 2Cl^-(aq) + Cu(OH)_2(s)$$

An ionic equation that shows all of the particles in a solution as they exist is called a **complete ionic equation.** Note that the sodium ions and the chloride ions are both reactants and products. Because they are both reactants and products, they do not participate in the reaction. Ions that do not participate in a reaction are called **spectator ions** and are not usually shown in ionic equations. **Net ionic equations** are ionic equations that include only the particles that participate in the reaction. Net ionic equations are written from complete ionic equations by removing all spectator ions. For example, a net ionic equation is what remains after the sodium and chloride ions are crossed out of this complete ionic equation.

$$\cancel{2Na^+(aq)} + 2OH^-(aq) + Cu^{2+}(aq) + \cancel{2Cl^-(aq)} \rightarrow \cancel{2Na^+(aq)} + \cancel{2Cl^-(aq)} + Cu(OH)_2(s)$$

Only the hydroxide and copper ions are left in the net ionic equation shown below.

$$2OH^-(aq) + Cu^{2+}(aq) \rightarrow Cu(OH)_2(s)$$

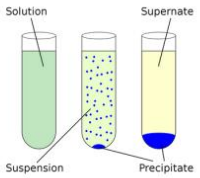
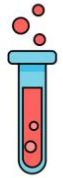
TO SOLVE THIS QUESTION INCLUDE THE FOLLOWING STEPS

BALANCE CHEMICAL EQUATION

Complete ionic equation

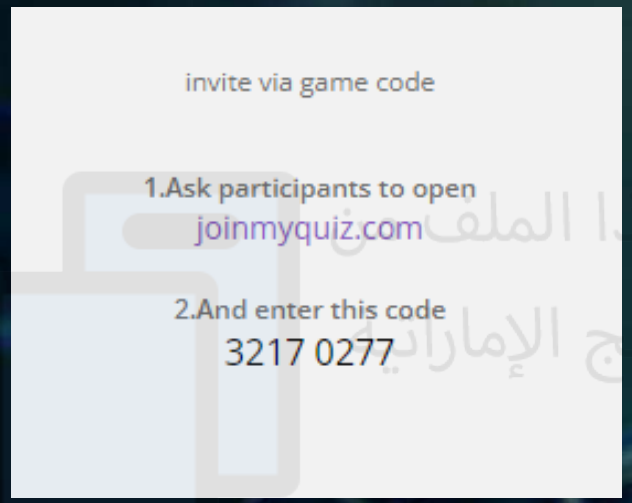
Ionic equation

Type of Reactions in Aqueous Solutions

Reactions that form Precipitate	Reactions that form Water	Reactions that form Gases
		
Exampls	Exampls	Exampls
$2OH^-(aq) + Cu2+(aq) \rightarrow Cu(OH)2(s)$	$HBr(aq) + NaOH(aq) \rightarrow H2O(l) + NaBr(aq)$	$H2CO3(aq) \rightarrow H2O(l) + CO2(g)$

CHAPTER 5 :THE MOLE

https://quizizz.com/join?gc=32170277



ASSESMENT

ON QUIZZEZ

Question #	Learning Outcomes	References in the student book	
24	Represent chemical reactions using different types of equations while illustrating their balancing process and its relation to the law of conservation of ma يمثّل التفاعلات الكيميائية باستخدام أنواع المعادلات المختلفة موضحًا عمليّة وزنها وعلاقتها بقانون حفظ الكتلة	Text book نص الكتاب	120

BOOK REFERENCE

Combustion Reactions

The synthesis reaction between sulfur dioxide and oxygen can also be classified as a combustion reaction. In a **combustion reaction,** such as the one shown in **Figure 9.8,** oxygen combines with a substance and releases energy in the form of heat and light. Oxygen can combine in this way with many different substances, making combustion reactions common. To learn more about the discovery of the chemical reaction for combustion and other reactions, review **Figure 9.9.**

A combustion reaction occurs between hydrogen and oxygen when hydrogen is heated, as illustrated in **Figure 9.10.** Water is formed during the reaction, and a large amount of energy is released. Another important combustion reaction occurs when coal is burned to produce energy. Coal is called a fossil fuel because it contains the remains of plants that lived long ago. It is composed primarily of the element carbon. Coal-burning power plants generate electric power in many parts of the United States. The primary reaction that occurs in these plants is between carbon and oxygen.

$$C(s) + O_2(g) \rightarrow CO_2(g)$$

Note that the combustion reactions just mentioned are also synthesis reactions. However, not all combustion reactions are synthesis reactions. For example, the reaction involving methane gas (CH_4) and oxygen illustrates a combustion reaction in which one substance replaces another in the formation of products.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

SAMMARY

Combustion reaction is a simple type of synthesis reaction, where a substance combines with oxygen and releases energy in the form of heat and light.

General Equation:	$X + O_2 \rightarrow XO_2$
Particulate Diagram:	
Examples:	$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$ $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $C_3H_{8\,(g)} + 5\,O_{2\,(g)} \rightarrow 3\,CO_{2\,(g)} + 4\,H_2O_{\,(l)}$ $2\,C_2H_{6(g)} + 7\,O_{2(g)} \rightarrow 4\,CO_{2(g)} + 6\,H_2O_{(l)}$ $C_3H_6O_{(l)} + 4\,O_{2(g)} \rightarrow 3\,CO_{2(g)} + 3\,H_2O_{(l)}$

Question #	Learning Outcomes	References in the student book
25	Explain the chain of chemical reactions that can occur in aqueous solutions يفسّر سلسلة التفاعلات الكيميائية التي يمكن أن تحدث في المحاليل المائية	Example5+ application questions مثال5+ أسئلة التطبيقات 136

REACTION TO FORM GAS

BOOK REFERENCE- Example 4

EXAMPLE Problem 9.5

Reactions That Form Gases Write the chemical, complete ionic, and net ionic equations for the reaction between hydrochloric acid and aqueous sodium sulfide, which produces hydrogen sulfide gas.

1 Analyze the Problem

You are given the word equation for the reaction between hydrochloric acid (HCl) and sodium sulfide (Na_2S). You must write the skeleton equation and balance it. To write the complete ionic equation, you need to show the ionic states of the reactants and products. By crossing out the spectator ions in the complete ionic equation, you can write the net ionic equation.

2 Solve for the Unknown

Write the correct skeleton equation for the reaction.

$HCl(aq) + Na_2S(aq) \rightarrow H_2S(g) + NaCl(aq)$

$2HCl(aq) + Na_2S(aq) \rightarrow H_2S(g) + 2NaCl(aq)$ — Balance the skeleton equation.

$2H^+(aq) + 2Cl^-(aq) + 2Na^+(aq) + S^{2-}(aq) \rightarrow H_2S(g) + 2Na^+(aq) + 2Cl^-(aq)$ — Show the ions of the reactants and the products.

$2H^+(aq) + \cancel{2Cl^-(aq)} + \cancel{2Na^+(aq)} + S^{2-}(aq) \rightarrow H_2S(g) + \cancel{2Na^+(aq)} + \cancel{2Cl^-(aq)}$ — Cross out the spectator ions from the complete ionic equation.

$2H^+(aq) + S^{2-}(aq) \rightarrow H_2S(g)$ — Write the net ionic equation in its smallest whole-number ratio.

Application Questions

PRACTICE Problems

Extra Practice Page 981 and glencoe.com

Write chemical, complete ionic, and net ionic equations for these reactions.

45. Perchloric acid ($HClO_4$) reacts with aqueous potassium carbonate, forming carbon dioxide gas and water.

46. Sulfuric acid (H_2SO_4) reacts with aqueous sodium cyanide, forming hydrogen cyanide gas and aqueous sodium sulfate.

47. Hydrobromic acid (HBr) reacts with aqueous ammonium carbonate, forming carbon dioxide gas and water.

48. Nitric acid (HNO_3) reacts with aqueous potassium rubidium sulfide, forming hydrogen sulfide gas.

49. Challenge Aqueous potassium iodide reacts with lead nitrate in solution, forming solid lead iodide.

45. Perchloric acid ($HClO_4$) reacts with aqueous potassium carbonate, forming carbon dioxide gas and water.

chemical equation: $2HClO_4(aq) + K_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g) + 2KClO_4(aq)$

complete ionic equation:
$2H^+(aq) + \cancel{2ClO_4^-}(aq) + \cancel{2K^+}(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g) + \cancel{2K^+}(aq) + \cancel{2ClO_4^-}(aq)$

net ionic equation:
$2H^+(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g)$

46. Sulfuric acid (H_2SO_4) reacts with aqueous sodium cyanide, forming hydrogen cyanide gas and aqueous sodium sulfate.

chemical equation: $H_2SO_4(aq) + 2NaCN(aq) \rightarrow 2HCN(g) + Na_2SO_4(aq)$

complete ionic equation:
$2H^+(aq) + \cancel{SO_4^{2-}}(aq) + \cancel{2Na^+}(aq) + 2CN^-(aq) \rightarrow 2HCN(g) + \cancel{2Na^+}(aq) + \cancel{SO_4^{2-}}(aq)$

net ionic equation: $2H^+(aq) + 2CN^-(aq) \rightarrow 2HCN(g)$ or $H^+(aq) + CN^-(aq) \rightarrow HCN(g)$

Continue : Application Questions

PRACTICE Problems

Extra Practice Page 981 and glencoe.com

Write chemical, complete ionic, and net ionic equations for these reactions.

45. Perchloric acid ($HClO_4$) reacts with aqueous potassium carbonate, forming carbon dioxide gas and water.

46. Sulfuric acid (H_2SO_4) reacts with aqueous sodium cyanide, forming hydrogen cyanide gas and aqueous sodium sulfate.

47. Hydrobromic acid (HBr) reacts with aqueous ammonium carbonate, forming carbon dioxide gas and water.

48. Nitric acid (HNO_3) reacts with aqueous potassium rubidium sulfide, forming hydrogen sulfide gas.

49. Challenge Aqueous potassium iodide reacts with lead nitrate in solution, forming solid lead iodide.

47. Hydrobromic acid (HBr) reacts with aqueous ammonium carbonate, forming carbon dioxide gas and water.

chemical equation: $2HBr(aq) + (NH_4)_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g) + 2NH_4Br(aq)$

complete ionic equation:
$2H^+(aq) + \cancel{2Br^-}(aq) + \cancel{2NH_4^+}(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g) + \cancel{2NH_4^+}(aq) + \cancel{2Br^-}(aq)$

net ionic equation:
$2H^+(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g)$

48. Nitric acid (HNO_3) reacts with aqueous potassium rubidium sulfide, forming hydrogen sulfide gas.

chemical equation: $2HNO_3(aq) + KRbS(aq) \rightarrow H_2S(g) + KRb(NO_3)_2(aq)$

complete ionic equation: $2H^+(aq) + 2NO_3^-(aq) + \cancel{K^+}(aq) + \cancel{Rb^+}(aq) + S^{2-}(aq) \rightarrow H_2S(g) + \cancel{K^+}(aq) + \cancel{Rb^+}(aq) + \cancel{2NO_3^-}(aq)$

net ionic equation: $2H^+(aq) + S^{2-}(aq) \rightarrow H_2S(g)$

49. Challenge Aqueous potassium iodide reacts with lead nitrate in solution, forming solid lead iodide.

chemical equation: $2KI(aq) + Pb(NO_3)_2(aq) \rightarrow 2KNO_3(aq) + PbI_2(s)$

complete ionic equation:
$\cancel{2K^+(aq)} + 2I^-(aq) + Pb^{2+}(aq) + \cancel{2NO_3^-(aq)} \rightarrow \cancel{2K^+(aq)} + \cancel{2NO_3^-(aq)} + PbI_2(s)$

net ionic equation: $Pb^{2+}(aq) + 2I^-(aq) \rightarrow PbI_2(s)$

GOOD LUCK

لا تنسونا من الدعاء بالتوفيق للجميع

EMAN ALHELALI - ALKHAIR SCOOL