

1	List different observations (or physical evidence) that indicate that a chemical reaction may be taking place	Textbook +	132,
		Figure 2	133

Chemical Reaction

(Also called Chemical Change)



is the process in which atoms of one or more substances are **rearranged to form new substances**.

Chemical reactions happen **all the time**, including: (when food is **cooked** / inside living **organisms** / in vehicle **engines** / in **factories** / in the **atmosphere**)

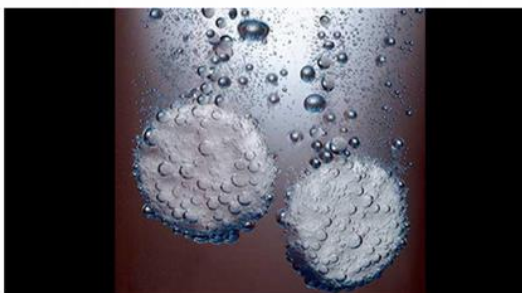
Evidence of a Chemical Reaction

1. **Temperature** change (heat released or absorbed) 2. **Color** change 3. **Gas** formation (Bubbles) 4. **Solid** formation (Precipitation) 5. **Odor** production 6. **Light** production (emission)

Color Change



Gas Formation



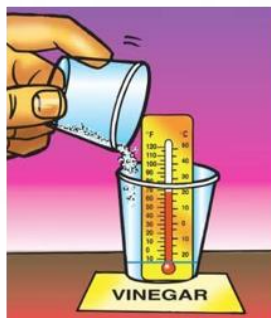
Color Change



Light Production



Odor Production



Temperature Change



Solid Formation



New substance = chemical reaction (gas, color, odor, light, heat, or precipitate).

Changes of state (melting, freezing, boiling) = physical changes.

Which figure illustrates evidence of a chemical reaction?



1

A green banana that turns yellow



2

Fireworks



3

Water boiling



4

Chocolate melting

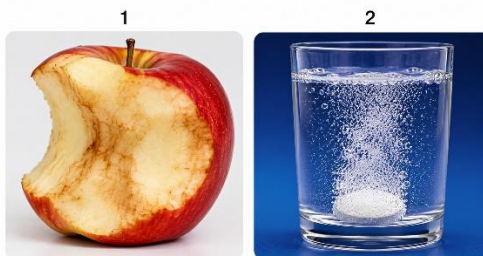
A) 2 and 3 only

B) 1 and 3 only

C) 1 and 2 only

D) 3 and 4 only

Regarding the figure below, which of the following is correct?



A) In (1), the change in the color of the apple is not evidence that a chemical reaction has occurred.

B) In (2), gas bubbles are not evidence that a chemical reaction has occurred.

C) In (1) and (2), apple color change and gas bubbles are evidence that a chemical reaction has occurred.

D) In (1), a chemical reaction occurred, while in (2) it did not.

In the figure below, what is the evidence that indicates a chemical reaction has occurred?



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A) Temperature change

B) Formation of a solid

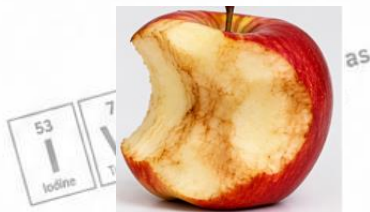
C) Gas bubbles

D) Color change

Which of the following is **NOT** evidence that a chemical reaction occurs?

- A) Temperature change B) Gas bubbles C) Color change D) A decrease in mass

What is the evidence for a chemical reaction in the following figure?



- A) Shape change B) Phase change C) Volume change D) Color change

Which of the following does **NOT** show evidence of a chemical reaction?



A



B

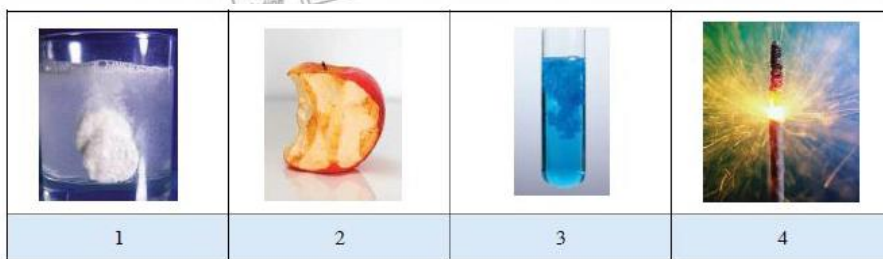


C



D

Which choice correctly matches each figure with the evidence of a chemical reaction?



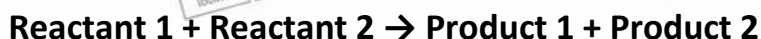
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	1	2	3	4
A	Releasing energy	Formation of a solid	Gas bubbles	Color change
B	Releasing energy	Gas bubbles	Color change	Formation of a solid
C	Color change	Formation of a solid	Gas bubbles	Releasing energy
D	Gas bubbles	Color change	Formation of a solid	Releasing energy

2	Identify the meaning of different symbols used in equations	Textbook + table 1	134
3	Identify the meaning of different symbols used in equations	Textbook + practice problems	135

Chemists use **chemical equations** to represent chemical reactions.

General form of a chemical equation:



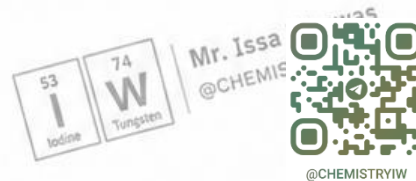
Reactants are the **starting substances** in a reaction. (Left)

Products are the **substances formed** during the reaction. (Right)

Symbol	Meaning
+	separates two or more reactants or products
→	separates reactants from products
⇌	shows a reversible reaction
(s)	solid
(l)	liquid
(g)	gas
(aq)	dissolved in water (aqueous)

What is the purpose of the symbol (⇌) in a chemical equation?

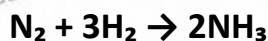
- A) Separates two or more reactants or products
- B) Identifies a water solution
- C) Separates reactants from products and indicates a reversible reaction
- D) Separates reactants from products and indicates a one-way reaction



What is the purpose of using the symbol (+) in a chemical equation?

- A) Identifies a liquid state
- B) Separates two or more reactants or products
- C) Identifies a water solution
- D) Separates reactants from products and indicates the direction of the reaction

What are the reactants and products in the following chemical reaction?



	Reactants	Products
A	N_2, H_2	NH_3
B	NH_3	N_2, H_2
C	N_2	H_2, NH_3
D	N_2, NH_3	H_2

Which symbol is used to separate reactants from products in a chemical equation?

A	+
B	\rightarrow
C	(aq)
D	Δ

Which symbol is used to indicate that a substance is dissolved in water in a chemical equation?

A	(s)
B	(l)
C	(aq)
D	(g)



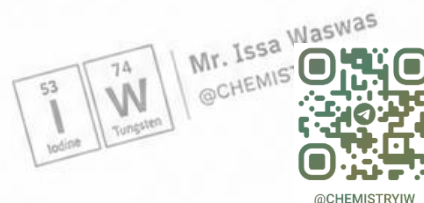
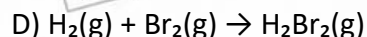
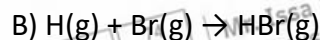
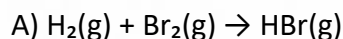
4	Write a skeleton equation for a word equation and vice versa	Textbook + practice problems	135
5	Write a skeleton equation for a word equation and vice versa	Textbook + practice problems	135

Word Equations	Skeleton Equations
Uses words to name the reactants and products	Uses chemical formulas instead of words
Both show Reactants and products Both show Physical States, (s), (l), (g)	
Does not show: Chemical formulas	Does not show: Amounts of reactants and products.
aluminum(s) + bromine(l) → aluminum bromide(s)	$\text{Al(s)} + \text{Br}_2\text{(l)} \rightarrow \text{AlBr}_3\text{(s)}$
Aluminum and bromine react to produce aluminum bromide	Shows what reacts and what forms, but not the amounts

Skeleton equation = chemical formulas + physical states not balanced (does not show amounts)

What is the correct skeleton equation that represents the chemical reaction below?

Hydrogen and bromine gases react to yield hydrogen bromide.



What is the correct skeleton equation that represents the chemical reaction below?

Solid sodium (Na) reacts vigorously with water (H₂O) to yield gaseous hydrogen (H₂) and a solution of sodium hydroxide (NaOH).

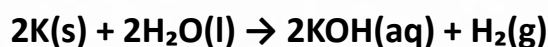
- A) $\text{Na(s)} + \text{H}_2\text{O(l)} \rightarrow \text{NaOH(aq)} + \text{H}_2\text{(g)}$
- B) $\text{NaOH(aq)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{(g)} + \text{Na(s)}$
- C) $\text{Na(aq)} + \text{H}_2\text{O(l)} \rightarrow \text{NaOH(s)} + \text{H}_2\text{(g)}$
- D) $\text{Na(s)} + \text{H}_2\text{O(l)} \rightarrow \text{NaH(aq)} + \text{O}_2\text{(g)}$

What is the correct skeleton equation that represents the chemical reaction below?

When heated, solid potassium chlorate (KClO₃) decomposes to produce solid potassium chloride (KCl) and oxygen gas.

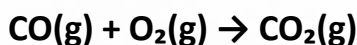
- A) $\text{KCl(s)} + \text{O}_2\text{(g)} \rightarrow \text{KClO}_3\text{(s)}$
- B) $\text{K(s)} + \text{Cl}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow \text{KClO}_3\text{(s)}$
- C) $\text{KClO}_3\text{(s)} \rightarrow \text{KCl(s)} + \text{O}_2\text{(g)}$
- D) $\text{KClO}_3\text{(l)} \rightarrow \text{KCl(aq)} + \text{O}_2\text{(s)}$

Which statement describes the following chemical equation?



- A) Solid potassium reacts with liquid water to produce potassium hydroxide solution and hydrogen gas.
- B) Calcium reacts with water to produce calcium hydroxide and hydrogen.
- C) Potassium hydroxide solution reacts with hydrogen gas to produce solid potassium and liquid water.
- D) Liquid potassium reacts with liquid water to produce potassium hydroxide and hydrogen gas.

Which statement describes the following chemical equation?



- A) Carbon dioxide gas reacts with oxygen gas to form carbon monoxide gas.
- B) Carbon and oxygen react to form carbon monoxide gas.
- C) Carbon monoxide gas and oxygen gas react to form carbon dioxide gas.
- D) Carbon monoxide liquid and oxygen gas react to form carbon dioxide solid.



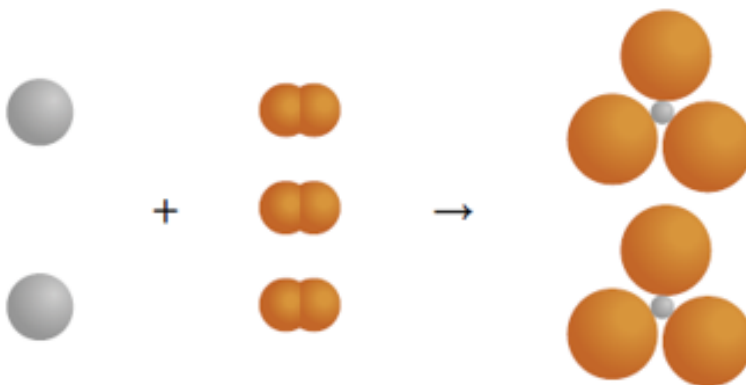
6	Balance different chemical equations	Textbook + figure 5 + table 2 + example problem 1 + practice problems	136 137 138
7	Explain why it is important to balance a chemical equation while identifying what is conserved		
8	Balance different chemical equations		

Balanced Chemical Equation

Chemical reactions follow the **law of conservation of mass**

It states that **Matter is neither created nor destroyed** during a chemical reaction

The **number of atoms** of each element **must** be the **same** on **both sides** of the **equation**



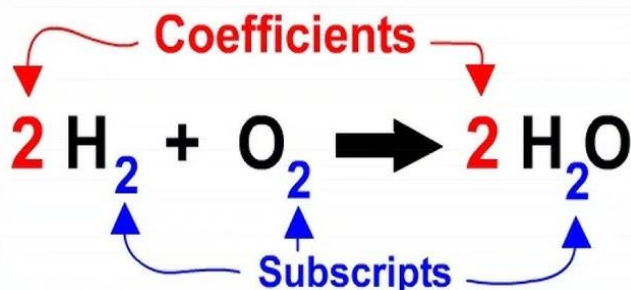
Two aluminum atoms

Six bromine atoms

Two aluminum atoms
Six bromine atoms

A **balanced equation** shows the **lowest whole-number ratio** of reactants and products.

Coefficients are whole numbers **written before** **chemical formulas** to show the amount of **each substance** in a reaction (1 is not written).



Formula	Atom count
H_2O	H = 2 O = 1
CO_2	C = 1 O = 2
Al_2O_3	Al = 2 O = 3
$Ca(OH)_2$	Ca = 1 O = 2 H = 2
$Al_2(SO_4)_3$	Al = 2 S = 3 O = 12
$(NH_4)_2CO_3$	N = 2 H = 8 C = 1 O = 3
$3H_2O$	H = 6 O = 3
$2Mg(NO_3)_2$	Mg = 2 N = 4 O = 12
$3Ca_3(PO_4)_2$	Ca = 9 P = 6 O = 24
$4Al_2(SO_4)_3$	Al = 8 S = 12 O = 48



Steps for Balancing Chemical Equations

Step	What to Do	Example
1	Write the skeleton equation with correct formulas.	$\text{H}_2 + \text{Cl}_2 \rightarrow \text{HCl}$
2	Count atoms on the reactant side.	Reactants: H = 2, Cl = 2
3	Count atoms on the product side.	Products: H = 1, Cl = 1
4	Change coefficients to balance atoms.	$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$
5	Make sure coefficients are the lowest whole numbers.	Coefficients: 1 : 1 : 2
6	Check that atoms are equal on both sides.	H = 2, Cl = 2 on both sides

What is the correct balanced equation that represents the chemical reaction written below?

Hydrochloric acid (HCl) reacts with solid aluminum (Al) metal to yield aqueous aluminum chloride (AlCl₃) and hydrogen gas (H₂).

- A) $2\text{Al}(\text{s}) + 6\text{HCl}(\text{g}) \rightarrow 2\text{AlCl}_3(\text{l}) + 3\text{H}_2(\text{aq})$
 B) $2\text{Al}(\text{s}) + 6\text{HCl}(\text{aq}) \rightarrow 2\text{AlCl}_3(\text{aq}) + 3\text{H}_2(\text{g})$
 C) $3\text{Al}(\text{aq}) + 3\text{HCl}(\text{aq}) \rightarrow 3\text{AlCl}_3(\text{aq}) + 3\text{H}_2(\text{g})$
 D) $2\text{AlCl}_3(\text{aq}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{Al}(\text{s}) + 6\text{HCl}(\text{aq})$

What is the correct balanced equation that represents the chemical reaction below?

Aqueous sodium hydroxide (NaOH) reacts with aqueous calcium bromide (CaBr₂) to produce solid calcium hydroxide (Ca(OH)₂) and aqueous sodium bromide (NaBr).

- A) $\text{NaOH}(\text{aq}) + \text{CaBr}_2(\text{aq}) \rightarrow \text{Ca}(\text{OH})_2(\text{s}) + \text{NaBr}(\text{aq})$
 B) $2\text{NaOH}(\text{aq}) + \text{CaBr}_2(\text{aq}) \rightarrow \text{Ca}(\text{OH})_2(\text{s}) + 2\text{NaBr}(\text{aq})$
 C) $\text{NaOH}(\text{s}) + \text{CaBr}_2(\text{aq}) \rightarrow \text{Ca}(\text{OH})_2(\text{aq}) + \text{NaBr}(\text{s})$
 D) $\text{Ca}(\text{OH})_2(\text{s}) + 2\text{NaBr}(\text{aq}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{CaBr}_2(\text{aq})$



What is the correct balanced equation that represents the chemical reaction below?

Iron(III) chloride (FeCl_3) reacts with sodium hydroxide (NaOH) in water to produce solid iron(III) hydroxide ($\text{Fe}(\text{OH})_3$) and sodium chloride (NaCl).

- A) $\text{FeCl}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s}) + \text{NaCl}(\text{aq})$
 B) $\text{FeCl}_3(\text{aq}) + 3\text{NaOH}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s}) + 3\text{NaCl}(\text{aq})$
 C) $\text{FeCl}_3(\text{s}) + 3\text{NaOH}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{aq}) + 3\text{NaCl}(\text{s})$
 D) $\text{Fe}(\text{OH})_3(\text{s}) + 3\text{NaCl}(\text{aq}) \rightarrow \text{FeCl}_3(\text{aq}) + 3\text{NaOH}(\text{aq})$

What is the correct balanced equation that represents the chemical reaction below?

Carbon disulfide reacts with oxygen to produce carbon dioxide and sulfur dioxide.

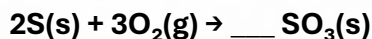
- A) $\text{CS}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{SO}_2$
 B) $2\text{CS}_2 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{SO}_2$
 C) $\text{CS}_2 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{SO}_2$
 D) $\text{CS}_2 + 3\text{O}_2 \rightarrow \text{CO}_2 + 2\text{SO}_2$

What is the correct balanced equation that represents the chemical reaction below?

Zinc reacts with dihydrogen sulfate to produce hydrogen and zinc sulfate.

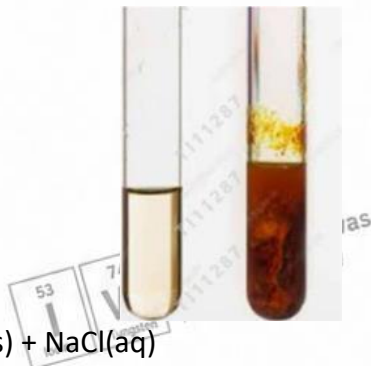
- A) $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2 + \text{ZnSO}_4$
 B) $2\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2 + 2\text{ZnSO}_4$
 C) $\text{Zn} + 2\text{H}_2\text{SO}_4 \rightarrow \text{H}_2 + \text{ZnSO}_4$
 D) $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow 2\text{H}_2 + \text{ZnSO}_4$

What is the correct coefficient that must be put in the blank in order for the following chemical equation to be balanced?



- A) 1 B) 2 C) 3 D) 4

A solution of iron(III) chloride reacts with a solution of sodium hydroxide to produce solid iron(III) hydroxide and a sodium chloride solution. What is the balanced chemical equation that expresses this reaction?

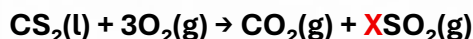


- A) $\text{FeCl}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s}) + \text{NaCl}(\text{aq})$
 B) $\text{FeCl}_3(\text{aq}) + 3\text{NaOH}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{aq}) + 3\text{NaCl}(\text{s})$
 C) $\text{FeCl}_3(\text{aq}) + 3\text{NaOH}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s}) + 3\text{NaCl}(\text{aq})$
 D) $\text{FeCl}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{aq}) + \text{NaCl}(\text{s})$



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When the following chemical equation is balanced, what is the value of the coefficient marked with the symbol X?



- A) 1 B) 2 C) 3 D) 4

A balanced chemical equation is a direct presentation of the _____.

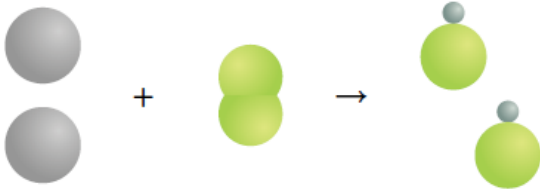
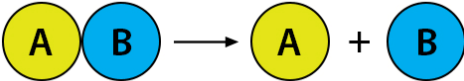
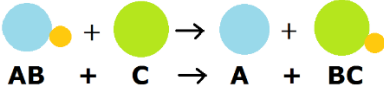
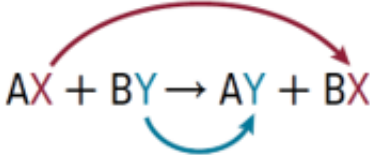
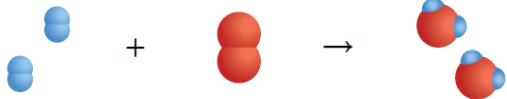
- A) Law of conservation of momentum B) Law of multiple proportions
 C) Ideal gas law D) Law of conservation of mass

Why is it important to balance a chemical equation?

- A) To increase the amount of products and conserve energy
 B) To ensure the number of atoms of each element is equal on both sides and mass is conserved
 C) To change the formulas of substances and conserve atoms
 D) To show the physical states of substances and conserve volume

9	Define a decomposition reaction while writing the general equation, particulate diagram, and some examples	Textbook + practice problems	142 143
10	Define a combustion reaction while writing the general equation, particulate diagram, and some examples	Textbook + figures 8 , 9 , 10 + practice problems	141 142
14	Define a synthesis reaction while writing the general	Textbook + figure 7	141
17	equation, particulate diagram, and some examples		142

Types of Chemical Reactions

	Definition	
Synthesis	in which two or more substances combine and form one compound.	$2\text{Na(s)} + \text{Cl}_2\text{(g)} \rightarrow 2\text{NaCl(s)}$ 
Decomposition	One compound breaks down and forms two or more substances.	
Single Replacement	One element replaces another element in a compound.	 $\text{AB} + \text{C} \rightarrow \text{A} + \text{BC}$
Double Replacement	The negative ions in two compounds switch places , forming two new compounds.	 $\text{AX} + \text{BY} \rightarrow \text{AY} + \text{BX}$
Combustion	in which a substance combines with oxygen and releases energy .	$2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{H}_2\text{O(g)}$ 

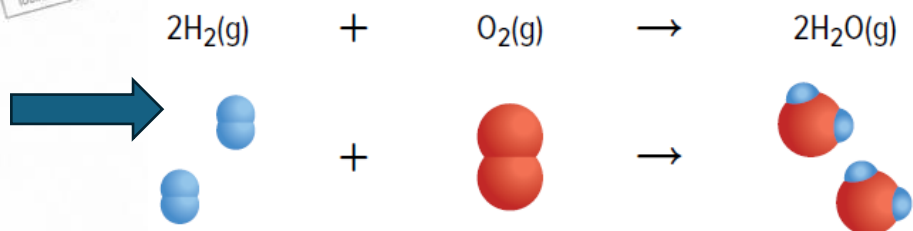
Type of Reaction	General Pattern	Example
Synthesis	$A + B \rightarrow AB$	$2Mg + O_2 \rightarrow 2MgO$
Decomposition	$AB \rightarrow A + B$	$2H_2O_2 \rightarrow 2H_2O + O_2$
Single Replacement	$A + BC \rightarrow AC + B$	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$
Double Replacement	$AB + CD \rightarrow AD + CB$	$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
Combustion	Hydrocarbon + $O_2 \rightarrow CO_2 + H_2O$	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Synthesis Reaction (One product)






Reactant type 1	Element + Element	$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$
Reactant type 2	Compound + Compound	$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$
Reactant type 3	Compound + Element	$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

Combustion Reaction (With O_2)

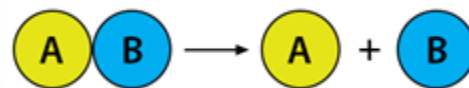


Energy change	Combustion reactions release a large amount of energy , usually observed as heat, light, or both .
Relationship to synthesis reactions	Some combustion reactions are also synthesis reactions because they produce one single product .

Examples of Combustion Reaction

<p>Example 1</p>	<p style="text-align: center;">Element + Oxygen $C(s) + O_2(g) \rightarrow CO_2(g)$</p> <p>Carbon combustion: occurs when coal is burned to produce energy.</p> <p>Application: Coal-burning power plants generate electricity through this combustion reaction.</p>
<p>Example 2</p>	<p style="text-align: center;">Hydrogen + Oxygen $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$</p> <p>Hydrogen combustion: The reaction occurs when hydrogen is heated. Water is formed</p>
<p>Example 3</p>	<p>Sparkler reactions demonstrate the combustion of oxygen with various metals, producing light.</p> <div style="text-align: center;">  </div>
<p>Example 4</p>	<p style="text-align: center;">Hydrocarbon + Oxygen $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$</p> <p>Methane Combustion produces more than one product (carbon dioxide and water). Not synthesis</p> <p>Methane is the major component of natural gas.</p> <p>All hydrocarbons burn in oxygen to produce carbon dioxide and water.</p> <div style="text-align: center;">  </div> <div style="text-align: right; margin-top: 20px;">  </div>

Decomposition Reaction (One Reactant)



Energy requirement

Decomposition reactions **often require an energy source. (Heat, light, or electricity)**

Real-Life Application: Air Bags (Decomposition Reaction)

- Sodium azide pellets (NaN_3) are stored inside the air bag.
- An **electric signal** triggers the decomposition reaction.
- Sodium azide decomposes: $2\text{NaN}_3(\text{s}) \rightarrow 2\text{Na}(\text{s}) + 3\text{N}_2(\text{g})$
- **Nitrogen gas (N_2)**, (harmless and causes the air bag to **inflate rapidly**)
- The reaction also produces **sodium metal (Na)** (highly reactive)



The sodium metal produced is highly reactive, so it reacts with other chemicals to form a safer compound, baking soda.

Which of the following diagrams represents a synthesis reaction?



What is a reaction of a substance with oxygen and releases energy in the form of heat and light?

- A) Decomposition reaction
- B) Combustion reaction
- C) Single replacement reaction
- D) Double replacement reaction

Which one of the following chemical reaction equations represents a synthesis reaction?

- A) $2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{KClO}_3(\text{s})$
- B) $\text{C}_5\text{H}_{12}(\text{l}) + 8\text{O}_2(\text{g}) \rightarrow 5\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$
- C) $2\text{Al}(\text{NO}_3)_3(\text{aq}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Al}_2(\text{SO}_4)_3(\text{aq}) + 6\text{HNO}_3(\text{aq})$
- D) $2\text{Pb}(\text{NO}_3)_2(\text{s}) \rightarrow 2\text{PbO}(\text{s}) + 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$

What is the type of chemical reaction represented in the equation below?



- A) Combustion reaction
- B) Double replacement reaction
- C) Single replacement reaction
- D) Decomposition reaction

Which of the following equations represents a decomposition reaction?

- A) $2\text{Al}(\text{s}) + 3\text{S}(\text{s}) \rightarrow \text{Al}_2\text{S}_3(\text{s})$
- B) $\text{N}_2\text{O}_5(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{HNO}_3(\text{aq})$
- C) $2\text{NaN}_3(\text{s}) \rightarrow 2\text{Na}(\text{s}) + 3\text{N}_2(\text{g})$
- D) $2\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{MgO}(\text{s})$



Which of the following equations represents a combustion reaction?

- A) $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
 B) $2\text{NaN}_3(\text{s}) \rightarrow 2\text{Na}(\text{s}) + 3\text{N}_2(\text{g})$
 C) $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
 D) $2\text{Al}(\text{s}) + 3\text{S}(\text{s}) \rightarrow \text{Al}_2\text{S}_3(\text{s})$

Why do automobile safety air bags inflate rapidly as sodium azide pellets decompose?



- A) Water vapor production
 B) Solid sodium production
 C) Nitrogen gas production
 D) Liquid nitrogen production

Which choice correctly matches each chemical reaction with its type?

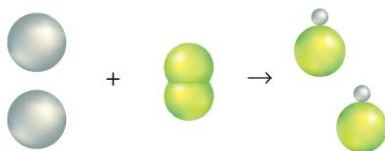
Reaction	Chemical equation
1	$2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$
2	$2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
3	$\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
4	$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$



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	1	2	3	4
A	Decomposition	Synthesis	Single replacement	Combustion
B	Synthesis	Combustion	Decomposition	Single replacement
C	Synthesis	Decomposition	Single replacement	Combustion
D	Single replacement	Decomposition	Synthesis	Combustion

Which type of reaction is shown in the figure?



- A) Combustion reaction
 B) Double replacement reaction
 C) Synthesis reaction
 D) Decomposition reaction

Which of these is NOT a synthesis reaction?

- A) $4\text{Al} + 3\text{S}_2 \rightarrow 2\text{Al}_2\text{S}_3$
 B) $\text{H}_2\text{O} + \text{N}_2\text{O}_5 \rightarrow 2\text{HNO}_3$
 C) $4\text{NO}_2 + \text{O}_2 \rightarrow 2\text{N}_2\text{O}_5$
 D) $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow 2\text{H}_2\text{O} + \text{Na}_2\text{SO}_4$

Which statement correctly describes a synthesis reaction?

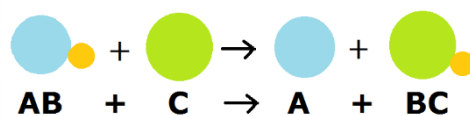
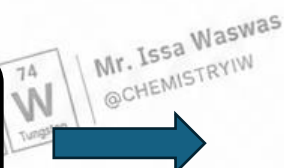
- A) One compound breaks down to form two or more substances.
 B) Two compounds exchange parts to form two new compounds.
 C) Two or more substances combine to form one compound.
 D) An element reacts with a compound to produce a new element and a new compound.



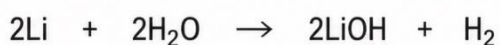
@CHEMISTRYIW

12	Use the activity (reactivity) series of metals to predict if a metal can replace hydrogen or another metal in a solution, while writing the products of the reaction, if any	Textbook + figures 12 , 13 + example	144
13	Use the activity (reactivity) series of halogens to predict if a halogen can replace another halogen in a solution while writing the products of the reaction, if any	problem 2 + practice problems	145 146

Single Replacement reaction (One replacement)



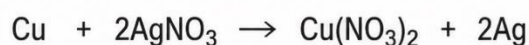
Lithium + Water



Lithium replaces hydrogen in water.



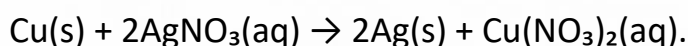
Copper + Silver Nitrate



Copper replaces silver in silver nitrate.

Metal Replaces Metal

- It happens **only** if the replacing metal is more reactive than the metal in the compound.



- A metal **can** replace any metal **below** it in the activity series.
- It **cannot** replace the metal **above** it.
- If the metal is less reactive, **no reaction (NR) occurs**.

Nonmetal Replaces Nonmetal (Halogens)

- A **more** reactive halogen can replace a less reactive halogen in a compound dissolved in water.
- For example, fluorine replaces bromine in sodium bromide:
- However, a less **reactive** halogen **cannot** replace a more **reactive** one, so no reaction occurs:



Most active

METALS

Lithium
Rubidium
Potassium
Calcium
Sodium
Magnesium
Aluminum
Manganese
Zinc
Iron
Nickel
Tin
Lead
Copper
Silver
Platinum
Gold

Least active

Most active

HALOGENS

Fluorine
Chlorine
Bromine
Iodine

Least active

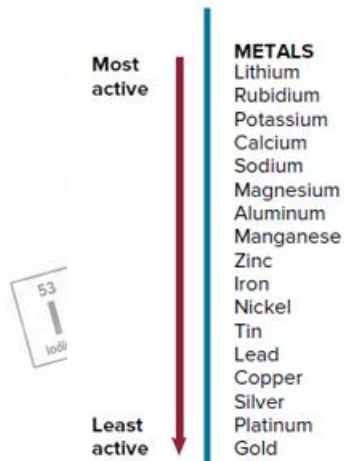
Which of the reactions in the table below is a single replacement reaction?

Reaction	Number
$\text{A} + \text{B} \rightarrow \text{AB}$	1
$\text{AB} \rightarrow \text{A} + \text{B}$	2
$\text{A} + \text{BX} \rightarrow \text{AX} + \text{B}$	3
$\text{AX} + \text{BY} \rightarrow \text{AY} + \text{BX}$	4

- A) 1
B) 2
C) 3
D) 4

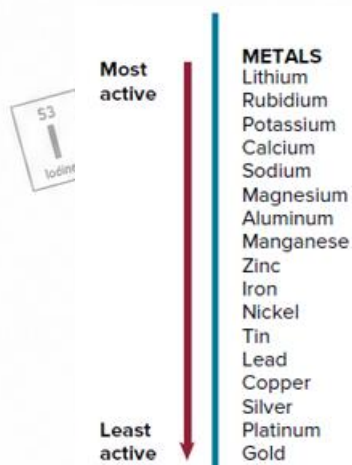


Using the reactivity series of metals, what would yield from the single replacement reaction of calcium (Ca) with zinc nitrate $Zn(NO_3)_2$?



- A) NR, No reaction
 B) $Zn(s) + Ca(NO_3)_2(aq)$
 C) $Zn(NO_3)_2(aq) + Ca(OH)_2(aq)$
 D) $CaCl_2(aq) + Zn(s)$

Using the activity series of metals, which of the following reactions does not occur?



- A) $Pb(s) + AgNO_3(aq) \rightarrow$
 B) $Ni(s) + AgNO_3(aq) \rightarrow$
 C) $Au(s) + AgNO_3(aq) \rightarrow$
 D) $Cu(s) + AgNO_3(aq) \rightarrow$



Using the chemical activity series in the figure below, which of these chemical reactions does not occur?

Most active	↓	METALS
		Lithium
		Rubidium
		Potassium
		Calcium
		Sodium
		Magnesium
		Aluminum
		Manganese
		Zinc
		Iron
		Nickel
		Tin
		Lead
		Copper
		Silver
		Platinum
Least active	↓	Gold

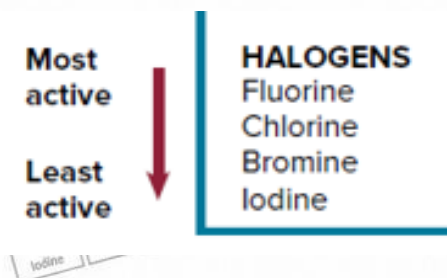


Using the chemical activity series below, which element will replace iron in iron(III) nitrate solution $\text{Fe}(\text{NO}_3)_3$?

Most active	↓	METALS
		Lithium
		Rubidium
		Potassium
		Calcium
		Sodium
		Magnesium
		Aluminum
		Manganese
		Zinc
		Iron
		Nickel
		Tin
		Lead
		Copper
		Silver
		Platinum
Least active	↓	Gold

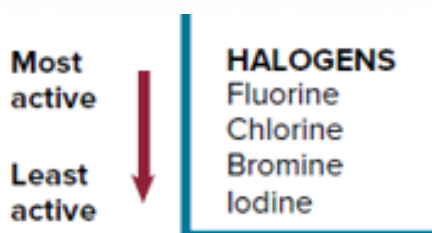


Using the halogens' reactivity series, what would be produced from the reaction of chlorine gas (Cl_2) with aqueous hydrogen fluoride solution (HF)?



- A) $\text{Cl}_2(\text{g}) + \text{F}_2(\text{g}) + \text{H}_2(\text{g})$
- B) NR, No Reaction
- C) $\text{HCl}(\text{aq}) + \text{F}_2(\text{g})$
- D) $\text{HF}(\text{aq}) + \text{HCl}(\text{aq})$

Using the halogens' reactivity series, what would be produced from the reaction of chlorine gas (Cl_2) with aqueous hydrogen bromide solution (HBr)?



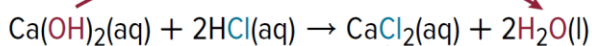
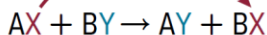
- A) NR, No Reaction
- B) $\text{HCl}(\text{aq}) + \text{Br}_2(\text{l})$
- C) $\text{HF}(\text{aq}) + \text{Cl}_2(\text{g})$
- D) $\text{BrCl}(\text{aq}) + \text{H}_2(\text{g})$



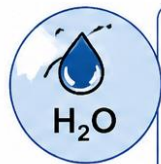
11	Define a double-replacement reaction while writing the general equation, particulate diagram, and some examples	Textbook + figures 12 , 13 ,	144 145
15	Describe what happens to the anions in a double-replacement reaction	15 + table 3 + practice	146 147
16	List three common types of products produced by reactions that occur in aqueous solutions	problems	148

Double Replacement Reactions

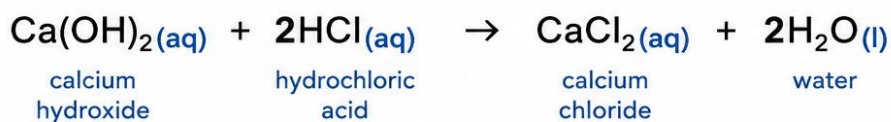
A **double-replacement reaction** is a reaction in which **two compounds exchange ions**. In this type of reaction, the **negative ions switch places**, forming **two new compounds**. In simple terms, parts of both compounds are replaced.



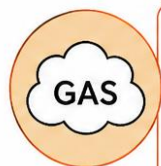
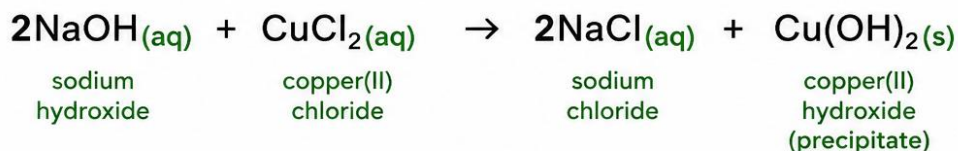
★ Double-replacement reactions always produce **water**, a **precipitate**, or a **gas**.



► Some reactions produce water:



► Some reactions produce solid (precipitate):



► Some reactions produce a gas:



Which of the following is a double replacement reaction?

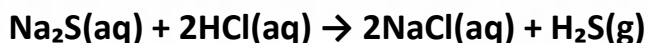
- A) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
 B) $Cu(s) + 2AgNO_3(aq) \rightarrow 2Ag(s) + Cu(NO_3)_2(aq)$
 C) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
 D) $2NaOH(aq) + CaBr_2(aq) \rightarrow Ca(OH)_2(s) + 2NaBr(aq)$

Which of the following chemical equations represent double-replacement reactions?

Reaction	Chemical equation
I	$LiI(aq) + AgNO_3(aq) \rightarrow AgI(s) + LiNO_3(aq)$
II	$2Al_2O_3(s) \rightarrow 4Al(s) + 3O_2(g)$
III	$2NaOH(aq) + CuCl_2(aq) \rightarrow 2NaCl(aq) + Cu(OH)_2(s)$
IV	$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$

- A) I only
 B) II and IV
 C) II only
 D) I and III

Regarding the following reaction, which of the following is correct?



Choice	Type of reaction in aqueous solution	Evidence of chemical reaction
A	Single displacement	Vigorous bubbling
B	Double displacement	Vigorous bubbling
C	Single displacement	Formation of precipitate
D	Double displacement	Formation of precipitate

In a double-replacement reaction, what happens to the anions?

- A) They break down into smaller particles.
- B) They switch places and bond with different cations.
- C) They combine together to form a new element.
- D) They remain with the same cations without any change.

Which statement correctly compares single-replacement and double-replacement reactions?

- A) Single-replacement reactions involve two compounds exchanging ions, while double-replacement reactions involve one element replacing another.
- B) Single-replacement reactions involve one element replacing another in a compound, while double-replacement reactions involve the exchange of ions between two compounds.
- C) Both single-replacement and double-replacement reactions involve only one compound.
- D) Both reactions always produce a gas as a product.

The figure shows the reaction between sodium hydroxide and copper(II) chloride. Which statement correctly describes the reaction type and the evidence of a chemical reaction?

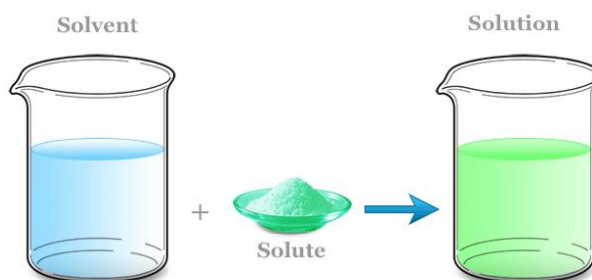


Choice	Type of reaction	Evidence of chemical reaction
A	Single replacement	Gas production
B	Double replacement	Gas production
C	Single replacement	Formation of a precipitate
D	Double replacement	Formation of a precipitate



18 Define aqueous **solution, solute, and solvent**19 Describe the difference in the behavior of **molecular compounds and ionic compounds** as solutes in aqueous solutionsTextbook +
figures 16 and
17150
151

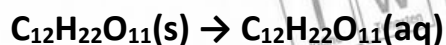
Aqueous Solutions



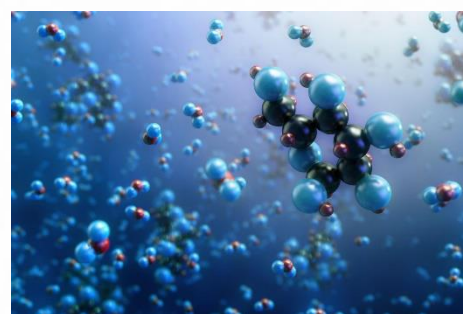
Aqueous solution	A solution in which substances are dissolved in water
Solute	A substance that is dissolved in the solution
Solvent	The most plentiful substance in the solution (water)

Molecular Compounds in Solution

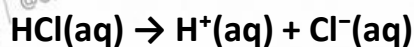
- Some solutes, such as **sucrose (table sugar)** and **ethanol (grain alcohol)**, exist as **molecules** in aqueous solutions.



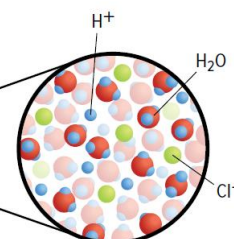
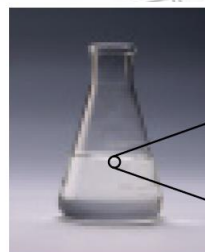
Exist as
Molecules



- Other solutes are molecular compounds that form **ions** when they dissolve in water. For example, the molecular compound **hydrogen chloride**.



Ionization
(Form ions)



Ionic Compounds in Solution

- Ionic compounds consist of **positive ions** and **negative ions** held together by **ionic bonds**.
- When ionic compounds dissolve in water, their ions can separate.

Always
Ions

Ionic compound

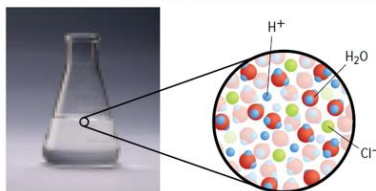
Dissociation

$$\text{NaCl(s)} \rightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$$

Which of the following is a solution of an ionic compound?

- A) Sodium chloride solution
- B) Sucrose solution
- C) Hydrogen chloride solution
- D) Ethanol solution

What is the solvent in aqueous solution of hydrochloric acid HCl(aq) ?



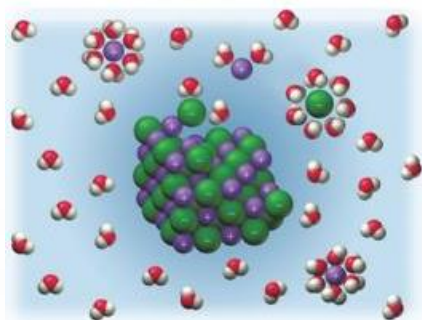
- A) Cl^-
- B) H_2O
- C) H^+
- D) HCl

The substance that is most plentiful in a solution is called _____.

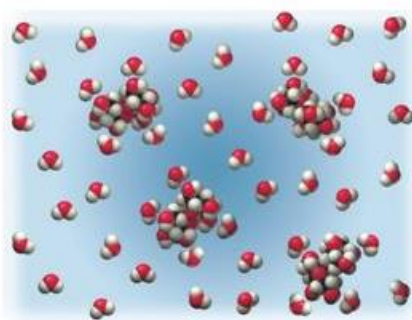
- A) Solvent
- B) Solute
- C) Ionic compound
- D) Molecular compound



Study the following figure. How does the solubility of sucrose (table sugar, $C_{12}H_{22}O_{11}$) differ from sodium chloride (NaCl) in aqueous solution?



Sodium chloride in water
كلوريد الصوديوم في الماء



Sucrose in water
السكروز في الماء

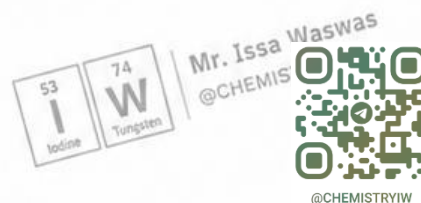
- A) Sodium chloride will dissolve in water and form ions, while sucrose will exist as molecules.
- B) Sucrose will dissolve in water and form ions, while sodium chloride will exist as formula units.
- C) Sucrose and sodium chloride will exist as molecules and formula units.
- D) Both sucrose and sodium chloride will dissolve in water and form ions.

Which statement about solute, solvent, and solution is incorrect?

- A) The solute is the substance that dissolves in a solution.
- B) The solvent is the substance present in the greatest amount in a solution.
- C) A solution is a homogeneous mixture of a solute and a solvent.
- D) The solute is always present in a greater amount than the solvent.

Which of the following exists as molecules when dissolved in water?

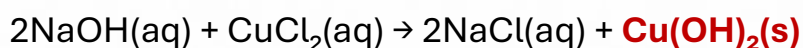
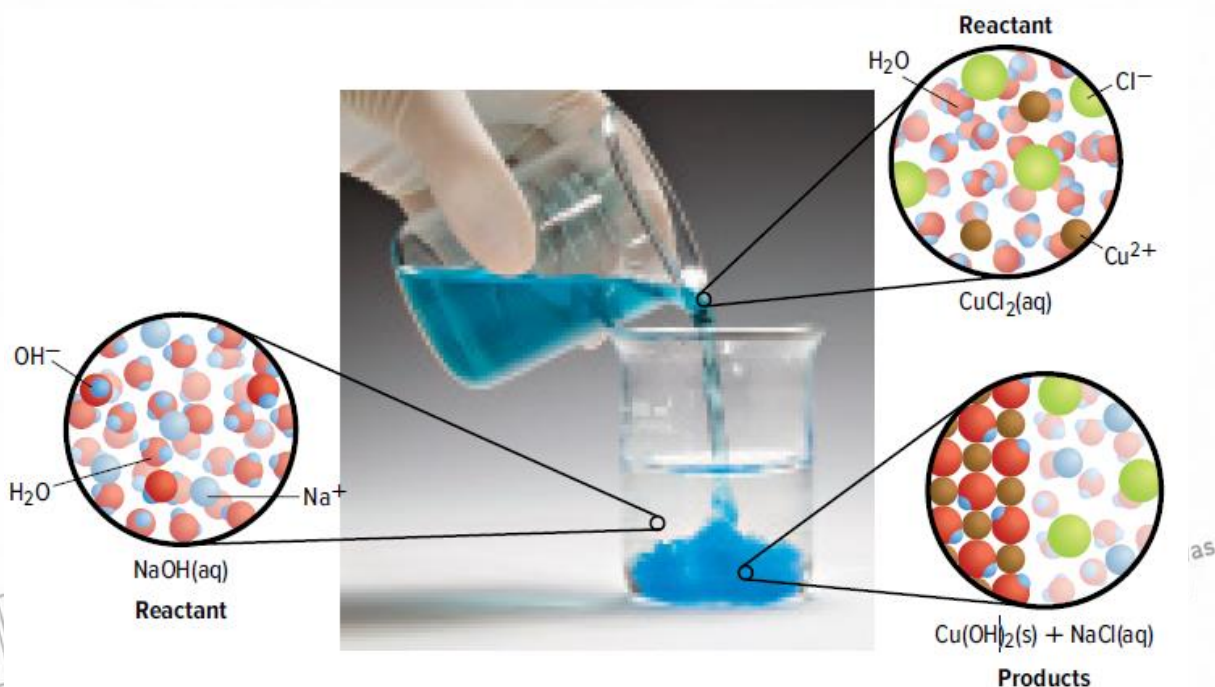
- A) Sodium chloride solution
- B) Sucrose solution
- C) Potassium chloride solution
- D) Calcium chloride solution

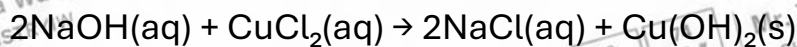


20	Write a balanced chemical equation, complete ionic equation, net ionic equation and word equation for reactions that form precipitates (using solubility rules)	Textbook + example problem 3 + practice problems	152
21			153
22	Define spectator ion, compare a net ionic equation and a complete ionic equation	Textbook + figure 18&19 + example problem 4&5 + practice problems	154
25			155
23	List three common types of products produced by reactions that occur in aqueous solutions		156
24			157

Reactions That Form Precipitates

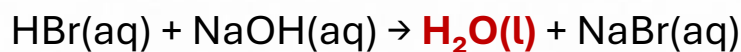
- A **precipitate** is an **insoluble solid** that forms during a reaction and separates from the solution.



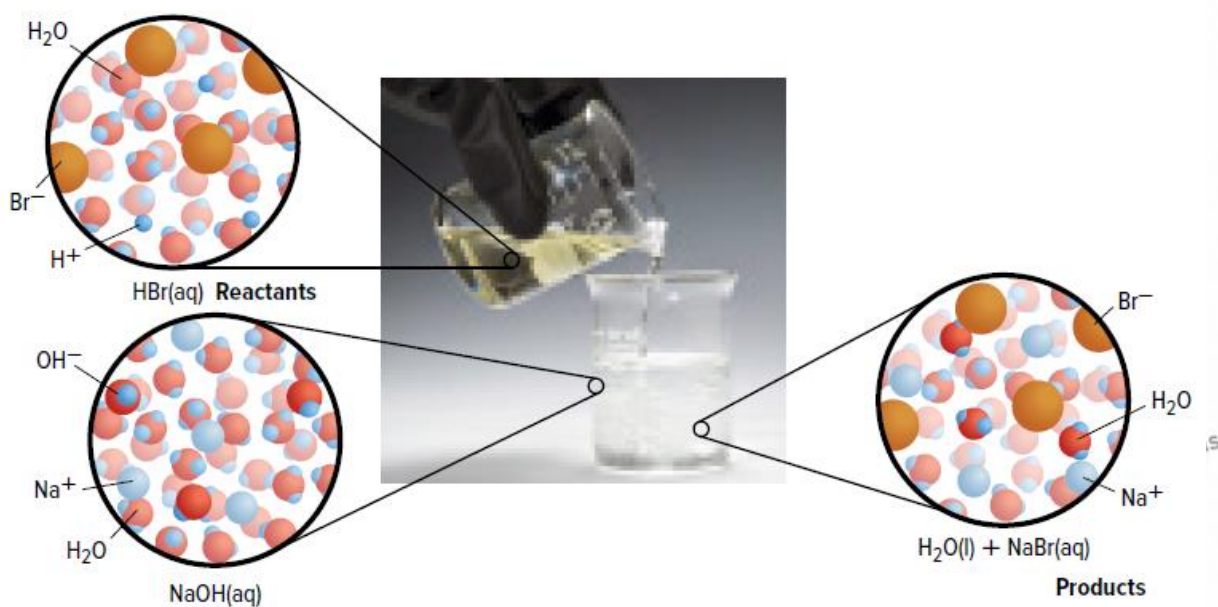


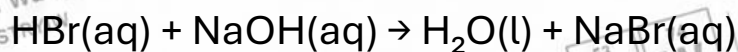
Complete ionic equation	An ionic equation that shows all of the particles in a solution as they exist , with substances written as ions.
	$2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) + \text{Cu}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) \rightarrow 2\text{Na}^+(\text{aq}) + 2\text{Cl}^-(\text{aq}) + \text{Cu}(\text{OH})_2(\text{s})$
Spectator ions	Ions that do not participate in a chemical reaction and appear as both reactants and products.
	$\text{Na}^+(\text{aq}), \text{Cl}^-(\text{aq})$
Net ionic equation	An ionic equation that includes only the particles that participate in the reaction , written after removing spectator ions.
	$2\text{OH}^-(\text{aq}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Cu}(\text{OH})_2(\text{s})$

Reactions That Form Water



@CHEMISTRYIW



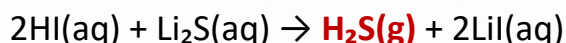


Item	Equation
Complete ionic equation	$\text{H}^+(\text{aq}) + \text{Br}^-(\text{aq}) + \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O(l)} + \text{Na}^+(\text{aq}) + \text{Br}^-(\text{aq})$
Spectator ions	$\text{Na}^+(\text{aq}), \text{Br}^-(\text{aq})$
Net ionic equation	$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O(l)}$

Reactions That Form Gases



@CHEMISTRYIW



Complete ionic equation	$2\text{H}^+(\text{aq}) + 2\text{I}^-(\text{aq}) + 2\text{Li}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{H}_2\text{S(g)} + 2\text{Li}^+(\text{aq}) + 2\text{I}^-(\text{aq})$
Spectator ions	$\text{Li}^+(\text{aq}), \text{I}^-(\text{aq})$
Net ionic equation	$2\text{H}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{H}_2\text{S(g)}$



Example: Vinegar and Baking Soda

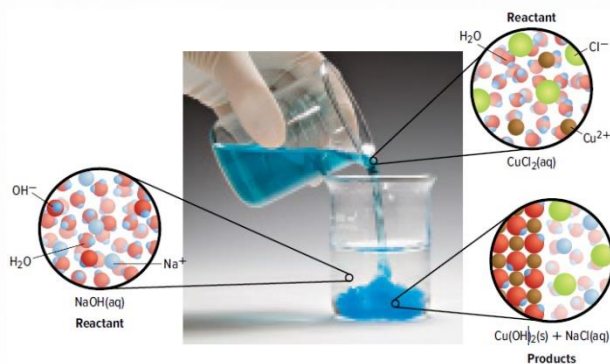
When **vinegar** (an aqueous solution of **acetic acid**) is mixed with **baking soda** (**sodium hydrogen carbonate**, NaHCO_3), **carbon dioxide gas** is produced. The rapid bubbling observed is due to **carbon dioxide gas escaping** from the solution.



Reactions that Take Place in Aqueous Solutions

Type of Reaction	Description
Reactions that form precipitates	Dissolved substances are mixed. When they react, a solid is produced, visible as a white or colored cloudiness in the reaction mixture.
Reactions that form water	Evidence of the reaction may not be observable because water is colorless, odorless , and already makes up most of the solution.
Reactions that form gases	Gases such as carbon dioxide, hydrogen cyanide, and hydrogen sulfide are produced. Bubbles are produced as the reaction proceeds.

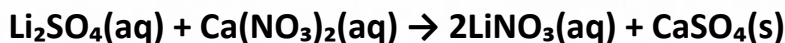
What happens when an aqueous sodium hydroxide solution is mixed with a solution of copper(II) chloride?



- A) No visible reaction occurs
- B) Solid copper(II) hydroxide precipitates out of the solution
- C) Solid copper metal is produced
- D) Chlorine gas is released during the reaction

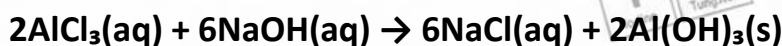


What is the complete ionic equation for the following reaction?



- A) $\text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{CaSO}_4(\text{s})$
- B) $2\text{Li}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Ca}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) \rightarrow 2\text{LiNO}_3(\text{aq}) + \text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
- C) $2\text{Li}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Ca}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) \rightarrow 2\text{Li}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + \text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
- D) $2\text{Li}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Ca}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) \rightarrow 2\text{Li}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + \text{CaSO}_4(\text{s})$

What is the complete ionic equation for the following reaction?



- A) $2\text{Al}^{3+}(\text{aq}) + 6\text{OH}^{-}(\text{aq}) \rightarrow 2\text{Al}(\text{OH})_3(\text{s})$
B) $2\text{Al}^{3+}(\text{aq}) + 6\text{Cl}^{-}(\text{aq}) + 6\text{Na}^{+}(\text{aq}) + 6\text{OH}^{-}(\text{aq}) \rightarrow 6\text{Na}^{+}(\text{aq}) + 6\text{Cl}^{-}(\text{aq}) + 2\text{Al}(\text{OH})_3(\text{s})$
C) $6\text{Na}^{+}(\text{aq}) + 6\text{Cl}^{-}(\text{aq}) \rightarrow 6\text{NaCl}(\text{s})$
D) $2\text{Al}^{3+}(\text{aq}) + 6\text{Cl}^{-}(\text{aq}) + 6\text{Na}^{+}(\text{aq}) + 6\text{OH}^{-}(\text{aq}) \rightarrow 6\text{NaCl}(\text{s}) + 2\text{Al}^{3+}(\text{aq}) + 6\text{OH}^{-}(\text{aq})$

Why in reactions that form water no evidence of a chemical reaction is observable?

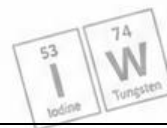
- A) Because water is colorless, odorless, and already makes up most of the solution
B) Because the number of solvent particles decreases
C) Because the number of solvent particles does not change
D) Because the water becomes colored, odorous, and already makes up most of the solution

Which of the reactions in aqueous solutions below produces a gas?

- A) $\text{HBr}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{NaBr}(\text{aq})$
B) $2\text{NaOH}(\text{aq}) + \text{CuCl}_2(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{Cu}(\text{OH})_2(\text{s})$
C) $2\text{HI}(\text{aq}) + \text{Li}_2\text{S}(\text{aq}) \rightarrow \text{H}_2\text{S}(\text{g}) + 2\text{LiI}(\text{aq})$
D) $\text{Ca}(\text{OH})_2(\text{aq}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$

Which of the reactions in aqueous solutions below produce a precipitate?

- A) $\text{HBr}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{NaBr}(\text{aq})$
B) $2\text{HI}(\text{aq}) + \text{Li}_2\text{S}(\text{aq}) \rightarrow \text{H}_2\text{S}(\text{g}) + 2\text{LiI}(\text{aq})$
C) $2\text{NaOH}(\text{aq}) + \text{CuCl}_2(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{Cu}(\text{OH})_2(\text{s})$
D) $\text{H}_2\text{SO}_4(\text{aq}) + \text{CaCO}_3(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + \text{CaSO}_4(\text{aq})$



What is the net ionic equation for the following reaction?



- A) $2\text{Na}^+(\text{aq}) + 2\text{Cl}^-(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq})$
 B) $\text{Ca}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Ca}(\text{OH})_2(\text{s})$
 C) $\text{Ca}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Ca}(\text{s}) + \text{O}_2(\text{g}) + \text{H}_2(\text{g})$
 D) $\text{Ca}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) + 2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{Na}^+(\text{aq}) + 2\text{Cl}^-(\text{aq}) + \text{Ca}(\text{OH})_2(\text{s})$

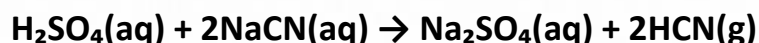
An ionic equation that shows all of the particles in a solution as they exist is called _____.

- A) General chemical equation
 B) Complete ionic equation
 C) Spectator ions equation
 D) Net ionic equation

What is the meaning of spectator ions?

- A) Ions that produce gas are released from the reaction
 B) Ions that produce a solid precipitate from the reaction
 C) The total ions in the solution of a reaction
 D) Ions that do not participate in the reaction and remain unchanged

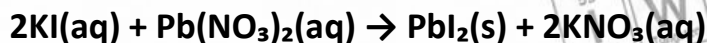
What are the spectator ions in the following reaction?



- A) H^+ and CN^-
 B) Na^+ and SO_4^{2-}
 C) H^+ and SO_4^{2-}
 D) Na^+ and CN^-



What is the type of chemical reaction shown in the following chemical equation?

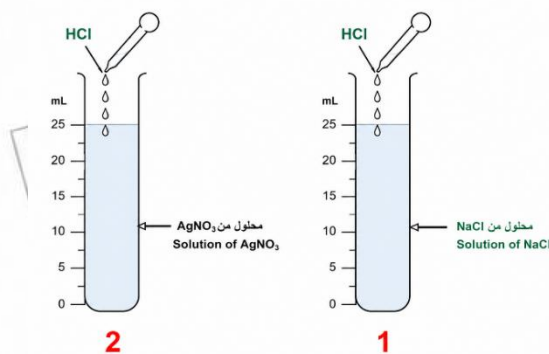


- A) Reaction that forms a gas
- B) Reaction that forms water
- C) Reaction that forms a precipitate
- D) Reaction that forms only aqueous products

When a chemical reaction takes place between the solutions of Na_2S and $\text{Mg}(\text{NO}_3)_2$, a precipitate of MgS is formed. What is the net ionic equation?

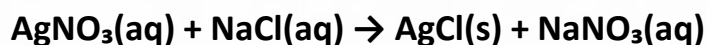
- A) $\text{Mg}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{MgS}(\text{s})$
- B) $\text{Mg}^{2+}(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{Mg}(\text{NO}_3)_2(\text{aq})$
- C) $\text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq})$
- D) $\text{Mg}(\text{NO}_3)_2(\text{aq}) + \text{Na}_2\text{S}(\text{aq}) \rightarrow \text{MgS}(\text{s}) + 2\text{NaNO}_3(\text{aq})$

The addition of hydrochloric acid to two test tubes containing solutions of either sodium chloride NaCl or silver nitrate AgNO_3 causes a white precipitate. Which of the following statements is correct?



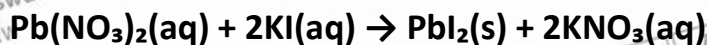
- A) The precipitate will form in both test tubes number 1 and 2
- B) The precipitate will not form in both test tubes number 1 and 2
- C) The precipitate will form in test tube number 2, and no precipitate will be formed in test tube number 1
- D) The precipitate will form in test tube number 1, and no precipitate will be formed in test tube number 2

What is the complete ionic equation for the following reaction?



- A) $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
 B) $\text{Ag}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$
 C) $\text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq})$
 D) $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq})$

What is the net ionic equation for the following reaction?



- A) $\text{Pb}^{2+}(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow \text{PbI}_2(\text{s})$
 B) $2\text{K}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq}) \rightarrow 2\text{KNO}_3(\text{aq})$
 C) $\text{Pb}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) \rightarrow \text{Pb}(\text{NO}_3)_2(\text{aq})$
 D) $\text{Pb}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + 2\text{K}^+(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2\text{K}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq})$

What are the spectator ions in the following reaction?



- A) Cu^{2+} and OH^-
 B) Na^+ and Cl^-
 C) Cu^{2+} and Cl^-
 D) Na^+ and OH^-

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