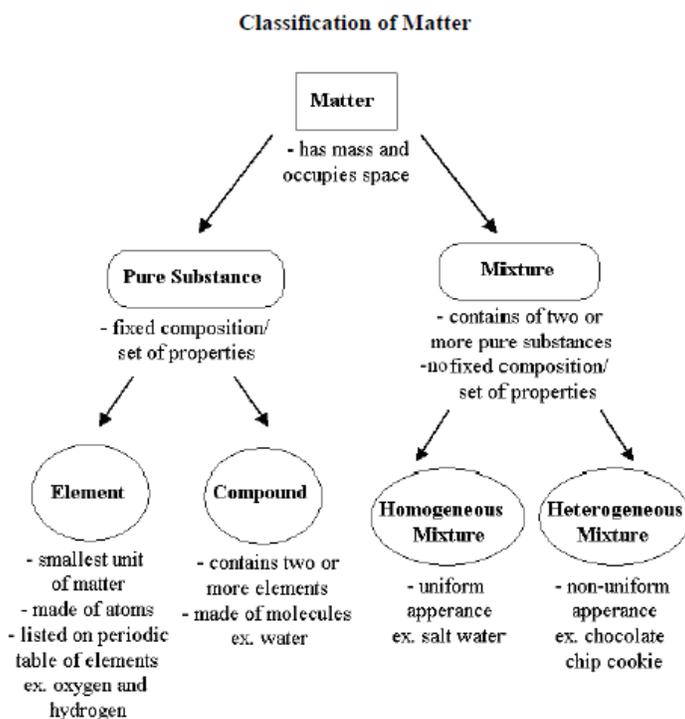


CHEMICAL CHANGES OF MATTER

Students should be able to....

- Define matter, mass, volume, pure substance, element, compound, homogeneous mixture, heterogeneous mixture.
- Compare and contrast pure substances and mixtures
- Classify substances as pure substance, element, compound, homogeneous mixture, heterogeneous mixture
- Define and describe the changes associated with a chemical reaction.
- Compare and contrast a physical and chemical changes.
- Write a chemical equation from a word description using the correct symbols.
- State the law of conservation of matter. Balance a chemical equations using the law of conservation of matter
- Classify a chemical reaction as synthesis, decomposition, single replacement, double replacement, or combustion given a balanced equation.
- State and explain the significance of diatomic atomic elements

What is matter? How is it classified?

*Fixed Composition:*

A pure substance always has a *fixed composition* because it is always composed of the same components in the same proportions (example: water is always made of two atoms of hydrogen and one atom of oxygen). A mixture has no fixed composition as the exact components and their proportions can vary (example: there are many different recipes for chocolate chip cookies with different ingredients and measurements).

Fixed set of Properties:

A pure substance always has *fixed properties* because it always behaves in the same way (example: water is always a clear colorless substance with a density of 1.00 g/mL that freezes at 0 °C and boils at 100 °C). A mixture has no fixed properties as the behavior depends its composition (example: every chocolate chip cookie has a slightly difference appearance and taste!).

MATTER CLASSIFICATION PRACTICE

1. Classify the following as a homogeneous or heterogeneous mixture.

- _____ a. a pail of sand and water
- _____ b. air
- _____ c. human blood
- _____ d. a banana split

- _____ e. chocolate syrup
 _____ f. sea water

2. Classify each of the following as an element or a compound.

- _____ a. benzene, C₆H₆
 _____ b. Aluminum, Al
 _____ c. aspirin, C₉H₈O₄
 _____ d. titanium, Ti
 _____ e. acetylene, C₂H₂
 _____ f. zinc, Zn

3. Determine which of the following are pure substances and which are mixtures.

- _____ a. salt water
 _____ b. isopropyl alcohol, C₃H₈O
 _____ c. mercury, Hg
 _____ d. ammonia, NH₃
 _____ e. an egg yolk
 _____ f. honey

What are changes of matter?

A **chemical change** is any change in matter that results in the formation of new chemical substances. At the molecular level, chemical change involves making or *breaking of chemical bonds* between atoms. These changes are chemical and typically irreversible. For example, using electricity to split water into hydrogen and oxygen gas.

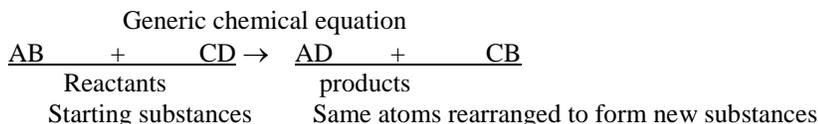
A **physical change** is any change of matter that does NOT involving a change in the substance's chemical identity. Here are some examples: (1) any phase change. Moving between solid, liquid and gas involves only the amount of energy in the sample. Many physical changes are reversible. For example, boiling water to form water vapor (steam)

PHYSICAL OR CHEMICAL CHANGES PRACTICE

Classify each change as a physical change or chemical change.

1. Burning paper. _____
2. Cutting paper. _____
3. Food digesting. _____
4. Sodium placed in water catches on fire and produces hydrogen gas and sodium hydroxide. _____
5. Slicing a piece of sodium in two. _____
6. Dissolving salt in water. _____
7. Milk becoming sour. _____
8. Wood rotting. _____
9. Cooking an egg. _____
10. Inflating a tire with air. _____
11. Condensation forming on a cold glass. _____
12. Iron rusting _____

Chemical equations are a shorthand or abbreviated way of representing chemical changes (reactions).

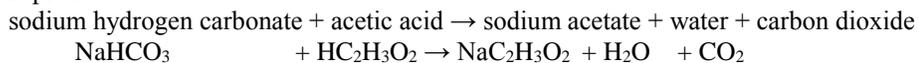


Use the following symbols to write a chemical equation.

- + _____
 → _____
 (aq) _____
 (s) _____
 (l) _____
 (g) _____
 Δ _____

In chemical reactions, the Law of Conservation of Mass is applied. The Law states matter cannot be created or destroyed. - In a chemical reaction, Therefore, the mass reactants = mass products.

Example: In the chemical equation written below, the mass of the sodium hydrogen carbonate is 84 g and the mass of the acetic acid is 60 g. At the end of the reaction, the mass of the sodium acetate is 82 g and the mass of the water is 18 g. What mass of carbon dioxide is produced?



Due to the Law of Conservation of Matter:

1. You must have the same type and amount of elements on both sides of the arrow.
2. You must remember HOFBrINCL. These atoms exist diatomically they are alone. If one is found alone, it must have a subscript of 2.
Example: Bromine gas is written as Br₂.
3. All ionic compounds in a chemical reaction must be written so that the positive charges cancel the negative charges to form a neutral compound.

EXAMPLES:

Solid copper metal	reacts with	A hydrochloric acid solution	to produce	a solution of copper (III) chloride	and	hydrogen gas.
()		()		()		()

Solutions of sodium phosphate	and	potassium chloride	react to make	solutions of potassium phosphate	and	sodium chloride.
()		()		()		()

Chemical Reactions

Write the chemical formulas for the reactants and products. Label the reactants and products for each reaction. Include the appropriate symbols to represent the state of matter for each substance.

Binary covalent compounds prefixes:

1-mono 2-di 3-tri 4-tetra 5-penta 6-hexa 7-hept 8-octa 9-nona 10-deca

1.

Solid sodium	is mixed with	solid sulfur	to produce	solid sodium sulfide
()		()		()

2.

Solid rubidium	reacts with	oxygen gas	to produce	solid rubidium oxide
()		()		()

3.

Solid disulfur dichloride	is added to	chlorine gas	to produce	solid sulfur dichloride
()		()		()

4.

Solid potassium	is added to	a solution of lead (II) nitrate	to produce	a solution of potassium nitrate	and solid lead
()		()		()	()

5.

When exposed to light, a solution of hydrogen peroxide (H ₂ O ₂)	decomposes to form	water	and	oxygen gas
()		()		()

6.

A piece of solid magnesium metal	is dropped into	a solution of zinc (II) chloride	to make	a solution of magnesium chloride	and solid zinc
()		()		()	()

NAME _____ DATE _____ PERIOD _____

BALANCING CHEMICAL EQUATIONS

- The law of conservation of matter (or energy) must be applied when balancing chemical equations.
- *The law of conservation of matter* (or energy) states matter (or energy) cannot be created or destroyed. This means that in a chemical reaction, the mass of reactants = the mass of the products
- The number and type of atoms should be the same on both sides of the arrow.
- **When balancing an equation, ONLY** coefficients can be added to the front of a molecule/compound.
- Multiply coefficients by all subscripts up until the next sign (→, +).

Example: Balance the following equations



Balance the following equations:

1. $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$
2. $\text{Al}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{Al}_2\text{O}_3(\text{s})$
3. $\text{N}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{NH}_3$
4. $\text{AgNO}_3(\text{aq}) + \text{Cu}(\text{s}) \rightarrow \text{Cu}(\text{NO}_3)_2(\text{aq}) + \text{Ag}(\text{s})$
5. $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
6. $\text{Na} + \text{I}_2 \rightarrow \text{NaI}$
7. $\text{KClO}_3 \rightarrow \text{KCl} + \text{O}_2$
8. $\text{K}_3\text{PO}_4 + \text{HCl} \rightarrow \text{KCl} + \text{H}_3\text{PO}_4$
9. $\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$
10. $\text{P}_4\text{O}_{10} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4$
11. $\text{Al} + \text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + \text{H}_2$
12. $\text{Be}_2\text{C} + \text{H}_2\text{O} \rightarrow \text{Be}(\text{OH})_2 + \text{CH}_4$
13. $\text{S} + \text{HNO}_3 \rightarrow \text{H}_2\text{SO}_4 + \text{NO}_2 + \text{H}_2\text{O}$
14. $\text{NH}_3 + \text{CuO} \rightarrow \text{Cu} + \text{N}_2 + \text{H}_2\text{O}$
15. $\text{Cu} + \text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{NO} + \text{H}_2\text{O}$

Write the complete, balanced equation for each of the following:

8. Aqueous potassium iodide reacts with aqueous lead (II) nitrate to yield solid lead (II) iodide and aqueous potassium nitrate
9. Solid aluminum reacts with oxygen gas to yield solid aluminum oxide
10. Aqueous magnesium chloride reacts with aqueous ammonium nitrate to yield aqueous magnesium nitrate and aqueous ammonium chloride
11. Solid iron plus liquid water react to form gaseous hydrogen and solid iron (III) oxide
12. Aqueous iron (III) chloride reacts with aqueous potassium hydroxide to form aqueous potassium chloride and solid iron (III) hydroxide
13. Aqueous sodium carbonate reacts with aqueous calcium hydroxide to yield aqueous sodium hydroxide and solid calcium carbonate
14. Solid sodium reacts with liquid water to form aqueous sodium hydroxide and gaseous hydrogen
15. Aqueous aluminum sulfate reacts with aqueous calcium hydroxide to form solid aluminum hydroxide and solid calcium sulfate

16. Aqueous potassium phosphate reacts with aqueous magnesium chloride to yield solid magnesium phosphate and aqueous potassium chloride
17. When solid calcium carbonate is heated it decomposes to form solid calcium oxide and carbon dioxide gas
18. Fluorine gas reacts with solid sodium hydroxide to form solid sodium fluoride, oxygen gas and liquid water
19. Gaseous hydrogen and gaseous oxygen react to form liquid dihydrogen monoxide
20. Aluminum bromide plus chlorine yield aluminum chloride and bromine.
21. Aluminum nitrate and sodium sulfide react to form aluminum sulfide and sodium nitrate.
22. Sodium sulfate reacts with calcium nitrate to produce sodium nitrate and calcium sulfate

Type of Chemical Reactions

Reactions Types

- Synthesis: $A + B \rightarrow AB$
Example: $2H_2 + O_2 \rightarrow 2H_2O$
- Decomposition: $AB \rightarrow A + B$
Example: $2NaCl \rightarrow 2Na + Cl_2$
- Single Replacement: $AB + C \rightarrow AC + B$ OR $AB + C \rightarrow CB + A$
* metals replace metals and non-metals replace non-metals!
Example: $2MgO + 2Cl_2 \rightarrow 2MgCl_2 + O_2$
*here, the non-metal chlorine replaces the non-metal oxygen)
Example: $CaS + 2Ag \rightarrow Ag_2S + Ca$ (here, the metal silver replaces the metal calcium)
- Double Replacement: $AB + CD \rightarrow AD + CB$ (both the metals and non-metals switch places)
Example: $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$
- Neutralization: acid + base \rightarrow salt + water acid: begins with a H base: ends with an OH salt: any ionic compound
water: H_2O - can be written as HOH example: $HCl + NaOH \rightarrow NaCl + H_2O$
- Combustion: hydrocarbon + oxygen \rightarrow carbon dioxide + water hydrocarbon: contains hydrogen and carbon
Example: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Complete the following problems by:

- Writing the correct chemical formula for each compound in the reaction (Hint: HOFBrINCl)
- Balancing the equation
- Identifying the type of reaction

23. aluminum + copper (II) chloride \rightarrow aluminum chloride + copper

Type: _____

24. gallium oxide \rightarrow gallium + oxygen

Type: _____

25. potassium bromide + lithium iodide \rightarrow lithium bromide + potassium iodide

Type: _____

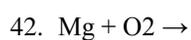
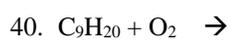
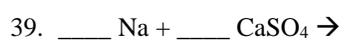
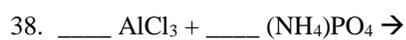
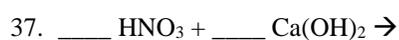
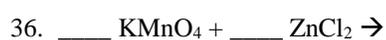
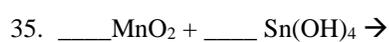
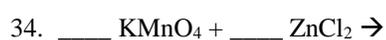
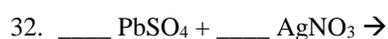
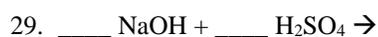
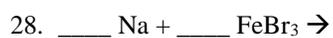
26. Methane gas reacts with oxygen to produce carbon dioxide and water.

Type: _____

27. Nitric acid reacts with calcium hydroxide to produce water and calcium nitrate

Type: _____

Predict, balance and classify the following chemical reaction



Chemical Reactions Review Sheet

- List the seven diatomic elements.
- What kind of visual clues(evidence) indicates that a chemical reaction has occurred?
- Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.
 - In a decomposition reaction, there is a single reactant.
 - The activity series of metals can be used to predict products in combustion reactions.
 - Carbon dioxide and water are the products of the combustion of hexane (C_6H_{14}).
- Balance the following reaction.
 - $NaBH_4 + BF_3 \rightarrow NaBF_4 + B_2H_6$
 - $NO + H_2 \rightarrow N_2 + H_2O$
 - $Fe_2O_3 + CO \rightarrow Fe + CO_2$
- Write a **balanced formula equation** for each of the following and **identify the reaction type**. Include the states of matter as possible.
 - The formation of solid copper (II) oxide from its elements _____
 - Combining solutions of aluminum sulfate and iron (II) chloride _____
 - Burning of gas ethane (C_2H_6) to release lots of energy _____
 - Reacting solid zinc and liquid bromine _____
 - Chlorine gas replaces bromide in solid sodium bromide _____
 - Adding solid ammonium sulfide to sodium chloride solution _____
 - Gaseous nitrogen monoxide reacts with gaseous carbon monoxide to form nitrogen gas and carbon dioxide gas. This reaction is catalyzed by platinum.
 - Zinc metal reacts with a solution of Hydrochloric acid to produce dissolved Zinc chloride and hydrogen gas.
 - A solution of Potassium hydroxide is heated in a test tube. A white precipitate (Potassium oxide) and water are produced.
- Predict the products for the following reactions
 - magnesium bromide + chlorine \rightarrow
 - aluminum + iron (III) oxide \rightarrow
 - silver nitrate + zinc chloride \rightarrow
 - cobalt(II) carbonate \rightarrow
 - zinc + hydrochloric acid \rightarrow
 - sulfuric acid + sodium hydroxide \rightarrow
 - aluminum + oxygen \rightarrow
 - acetic acid + copper \rightarrow