

3.8 – 3.9 Balancing Chemical Equations, Reaction Types

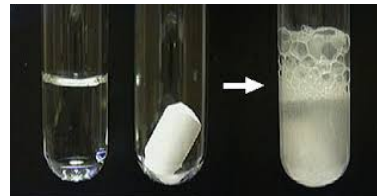


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Chemical Reaction

Chemical Change: when elements rearrange to make a different compound.

1. With a table partner, put an MRE fragment in water in a small test tube, and record your observations of the entire process. Capture the gas in a large test tube, and after a few seconds, insert a burning splint into the large tube. What do you think the gas is?



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Evidence of Chemical Reaction

Indications that a chemical change may have occurred:

Temperature change:

Exothermic - releases heat

Endothermic - absorbs heat

Generation of gas (odor)

Generation of light



Color change

Formation of solid, called a precipitate.
Cu(OH)₂ Demo.

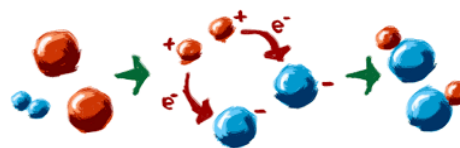


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Representing Chemical Reactions

Chemical equations show reactants forming products:

Reactant(s) → Product(s)



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Equation Symbols

Equations show states of matter:

Solids = (s) Ex: CaCl_{2(s)}

Liquids = (l) Ex: H₂O_(l)

Gases = (g) Ex: H_{2(g)}

Aqueous Solutions (dissolved in water) = (aq)



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Predicting States of Matter

You will not always be given explicit states of matter (or formulas) in reactions.

Some Rules of Thumb at room temperature are:

1. All metals and metalloids are solid except mercury which is liquid.
2. All nonmetals are gaseous except bromine (liquid), and carbon, sulfur, phosphorus, and iodine, which are solid.
3. Ionic compounds, unless dissolved, are solid.
4. Note seven diatomic elements: H₂, N₂, O₂, F₂, Cl₂, Br₂, and I₂: the Gen-u-Ine elements (Ions List page).
5. Elemental sulfur is octatomic: S₈, but is not always reported thusly.
6. Assume acids are aqueous.

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3 Equation Types

1. Word Equation describes the reaction.

Ex: Aluminum metal and liquid bromine react, forming aluminum bromide.

2. Skeleton Equation lists formulas / states of matter of reactants and products (not balanced).

Ex: $\text{Al}_{(s)} + \text{Br}_{2(l)} \rightarrow \text{AlBr}_{3(s)}$

3. Balanced Equation shows correct amounts of reactants and products with coefficients.

Ex: $2\text{Al}_{(s)} + 3\text{Br}_{2(l)} \rightarrow 2\text{AlBr}_{3(s)}$

Coefficients

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Balancing Equations Process:

1. Write skeleton equation.
2. Count atoms or polyatomic ions in reactants and products.
3. Change coefficients to make number of atoms/ions equal on both sides.
4. Write coefficients in lowest ratio.
5. Check your work – do atoms add up?

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2. Word Example

Aqueous solutions of sodium hydroxide and calcium bromide react, forming solid calcium hydroxide and aqueous sodium bromide.

Make a skeleton equation with correct formulas of reactants and products (including states of matter), then balance the reaction.

$2\text{NaOH}_{(aq)} + \text{CaBr}_{2(aq)} \rightarrow \text{Ca(OH)}_{2(aq)} + 2\text{NaBr}_{(aq)}$

Does it check out?

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3. Sodium Oxide Example

Solid sodium metal reacts with oxygen, forming solid sodium oxide.

Determine the formulas and states of the compounds, then make a balanced equation.

$4\text{Na}_{(s)} + \text{O}_{2(g)} \rightarrow 2\text{Na}_2\text{O}_{(s)}$



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4. Sodium Oxide Dissolution

Many metal oxides will react with water by hydrolyzation (splitting), forming a metal hydroxide. Many of these are sparingly soluble, but we will discuss solubility rules later.

This happens with sodium oxide, the product of which is quite soluble. Write and balance this reaction.

$\text{Na}_2\text{O}_{(s)} + 2\text{H}_2\text{O}_{(l)} \rightarrow 2\text{NaOH}_{(aq)}$

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Chemical Reaction Types

We study six basic types of chemical reaction:

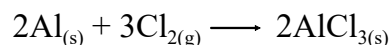
1. Synthesis: $\text{A} + \text{B} \rightarrow \text{AB}$
2. Decomposition: $\text{AB} \rightarrow \text{A} + \text{B} (+ \text{More?})$
3. Combustion: $\text{C}_x\text{H}_y + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
4. Single Replacement: $\text{A} + \text{BX} \rightarrow \text{AX} + \text{B}$
5. Double Replacement: $\text{AX} + \text{BY} \rightarrow \text{AY} + \text{BX}$
6. Acid/Base: $\text{HA} + \text{BOH} \rightarrow \text{BA} + \text{H}_2\text{O}$
Useful to write water as HOH: 1 hydrogen : 1 hydroxide.
More complex redox reactions will appear later.

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Synthesis

Two reactants combine, making one product.

5. Aluminum and chlorine gas react, forming aluminum chloride.



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Decomposition

Opposite of synthesis. One reactant breaks into two or more products.

6. Ammonium nitrate decomposes into gaseous dinitrogen monoxide and water.

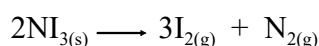


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Gratuitous Decomposition Video

Solid nitrogen triiodide decomposes into iodine vapor and nitrogen.

7. Balance this, then we can watch the video!



NI3 one.MOV

NI3 two.MOV

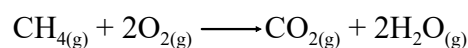


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Combustion

A hydrocarbon reacts with oxygen forming **water** and **carbon dioxide**.

8. Methane (CH_4) gas burns in air, making carbon dioxide and water vapor.

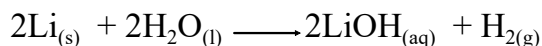


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Single Replacement (The Bully Reaction)

One elemental reactant replaces another one.

9. Lithium and water react, forming aqueous lithium hydroxide and hydrogen.

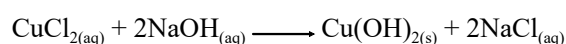


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Double Replacement (Square Dancing Reaction)

Reactants switch partners.

10. Solutions of copper (II) chloride and sodium hydroxide react to form solid copper (II) hydroxide and sodium chloride.



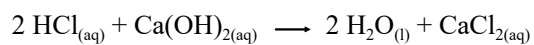
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Acid/Base

A type of double replacement reaction: acid (H^+) and base (OH^-) form water (HOH) and a salt (ionic compound).

Use Acid List if necessary (Resources P. 6).

11. Solutions of hydrochloric acid and calcium hydroxide form water and dissolved calcium chloride.



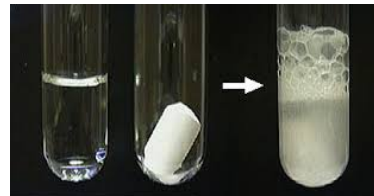
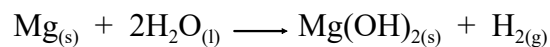
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Revisiting the MRE Demo

The active ingredient in the MRE is magnesium dust, with salt and iron dust to help things get going.

12. Knowing that magnesium is the active ingredient, predict all products and balance the reaction including states of matter.

Hint: the milky substance is a solid product.



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Homework

Read 3.10 - 3.11

Complete the Prelab for Lab 1.1:
Empirical Formula of Silver Oxide

3.8 - 3.9 Problems in your Booklet
Due: Next Class.

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Attachments

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NI3 two.MOV