



Chapter Fourteen: Changes in Matter

- **14.1 Chemical Reactions**
- **14.2 Types of Reactions**
- **14.3 Energy and Chemical Reactions**
- **14.4 Nuclear Reactions**



Chapter 14.2 Learning Goals

- **Classify reactions based on how atoms combine to create new substances.**
- **Discuss applications of polymer science.**
- **Study examples of combustion reactions.**



14.2 Synthesis reactions

- In a synthesis reaction, two or more substances combine to form a new compound.





14.2 Synthesis reaction



Remember to balance!

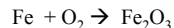


Generally these synthesis reactions are:

two elements combine to produce a single compound OR

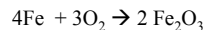
two compounds (of which one is usually water or oxygen) combine to form a single compound

When iron combines slowly over time with oxygen:



For simplicity sake, textbook shows the UNBALANCED reaction using chemical symbols.

When iron combines slowly over time with oxygen:



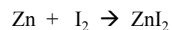
Set up Demonstrations (account for enough materials for one per class)

CPO video series or teacher can film the reactions ahead of time

The result is a rusty nail. Use a nail or other piece of iron metal that has been spritzed with water several days head of time and then dried to pass around.

Mention that other metals when combined with oxygen become weakened or corroded, such as Al or Mg or Ag on exposure to air over time. These are very slow chemical reactions and are “oxidations”

Also elemental zinc can combine with iodine:



Extension demo for advanced students***:

materials: match, superfine steel wool (size 0000), ring stand, metal jawed test tube clamp, alum pie pan, balance, goggles

Find the mass of a steel wool pad (w/o soap) .

The pad can be ignited with a single match if clipped with metal jawed tube clamp to a ring stand. (CAUTION: the pad will ignite quickly!)

If the product is collected on an aluminum pie pan whose mass is also known before hand, the mass of the product and the pan can be measured. When the pan’s mass is subtracted, observers will notice that the mass of the product is greater than that of the starting mass of the steel wool pad.



14.2 Synthesis reactions

- The process of creating large molecules from small ones is called **polymerization**.



Common Polymers	Polymer Products
polystyrene	foam containers
polyethylene	food packaging
polyester	clothing
polyvinyl chloride	plumbing (PVC pipes)
polyvinyl acetate	chewing gum



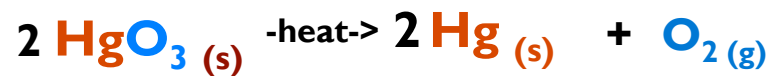
14.2 Decomposition reactions

- A chemical reaction in which a single compound is broken down to produce two or more smaller compounds is called a decomposition reaction.





14.2 Decomposition reaction



Generally these reactions are:

a single binary compound decomposing to form two elements

OR

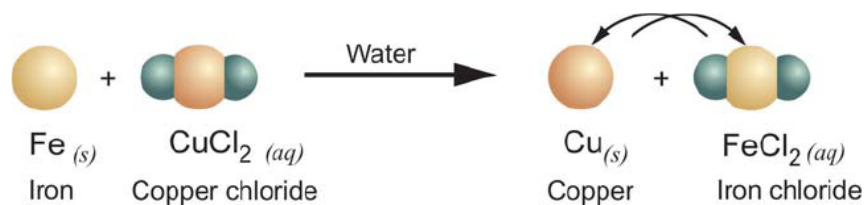
a single ternary compound decomposing to form an element and a compound or two compounds

Most require the input of energy in the form of heat, light or electricity.



14.2 Single Displacement

- In a single-displacement reaction, one element replaces a similar element in a compound.





14.2 Single Displacement



This reaction shows:

-one element combining with one compound to form a new compound with a different element precipitated

Generally they are performed in “aqueous solutions” (dissolved in a water medium to facilitate the reaction)

Other metals when combined with oxygen become weakened or corroded, such as Al or Mg metals with exposure to air over time.

* Remember, for iron to replace copper, copper must be higher on the activity series of metals, copper is Cu^{2+} and iron Fe^{2+}



14.2 Double Displacement

- In a double-displacement reaction, ions from two compounds in solution exchange places to produce two new compounds.
- One of the compounds formed is usually a precipitate that settles out of the solution, a gas that bubbles out of the solution, or a molecular compound such as water.





14.2 Double Displacement



Generally these reactions are:

two ionic compounds combining to produce two new compounds

Generally they are performed in "aqueous solutions" (dissolved in a water medium to facilitate the reaction)

When aqueous lead (II) nitrate combines with aqueous potassium iodide it yields lead iodide and potassium nitrate. The solution changes from white to fluorescent yellow.

Other metals when combined with oxygen become weakened or corroded, such as Al or Mg metals on exposure to air over time.



14.2 Double displacement

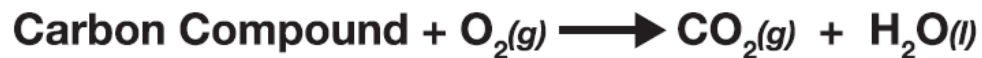


- A precipitate is a new solid product that comes out of solution in a chemical reaction.
- The formation of a cloudy precipitate is evidence that a double-displacement reaction has occurred.



14.2 Combustion reactions

- A combustion reaction, also called burning, occurs when a substance such as wood, natural gas, or propane combines with oxygen and releases a large amount of energy in the form of light and heat.



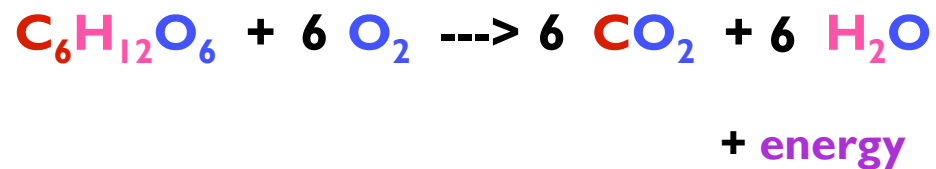
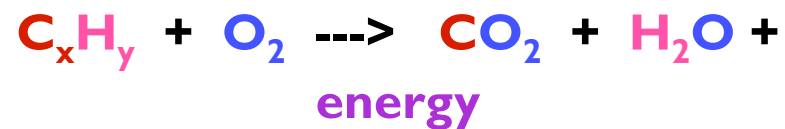


14.2 Combustion reactions

Carbon Compound	Chemical Formula
methane	CH ₄
ethane	C ₂ H ₆
propane	C ₃ H ₈
butane	C ₄ H ₁₀
pentane	C ₅ H ₁₂
hexane	C ₆ H ₁₄
heptane	C ₇ H ₁₆
octane	C ₈ H ₁₈

- What do reactants like wood, natural gas, and propane have in common?

14.2 Combustion



Generally:
 when a compound containing C, H, O reacts in the presence of oxygen it produces carbon dioxide and water
 produce large amounts of energy in the form of heat or light
 if the combustion is incomplete, carbon monoxide or elemental carbon may be formed

When methane reacts with oxygen, carbon dioxide and water is produced.
 This is the reaction that takes place in a typical gas stove or heater or in a Bunsen burner.
 The delivered gas is poisonous/toxic to humans, so a “stench agent” is added for safety.