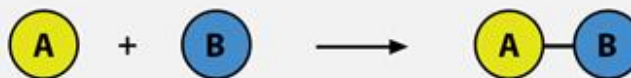


# Chemical Change

## AKA Chemical Reaction

- Involves joining, separation or rearrangement of atoms of substances that react.
- Involves forming or breaking chemical bonds.
- Often *impossible or difficult to reverse*.

### 1. Combination or Synthesis Reaction



### 2. Decomposition Reaction



### 3. Single-replacement Reaction



### 4. Double-replacement Reaction



# Chemical Change

## AKA Chemical Reaction

A chemical change occurs when matter changes chemically **into an entirely different substance** with different properties

- **Silver *tarnishes*.**  
The **solid silver** reacts with **sulfur in the air** to make **solid silver sulfide**, the black material we call *tarnish*.



Chemical change is often ***difficult or impossible to reverse***.

# Chemical Reaction Examples



When vinegar (liquid) and baking soda (solid) combine, they form **carbon dioxide (gas that is denser than air)**, **water (liquid)** and **sodium acetate (a salt, which dissolves in water)**.

**2015 Guinness World Record:** the **largest baking soda and vinegar volcano was over 28 feet tall**, achieved by pupils, parents and staff of Elmfield Steiner School (UK) on 9 May 2015. The eruption was prepared using 100 liters of vinegar and 100 liters of a baking soda and water solution (colored with red dye).

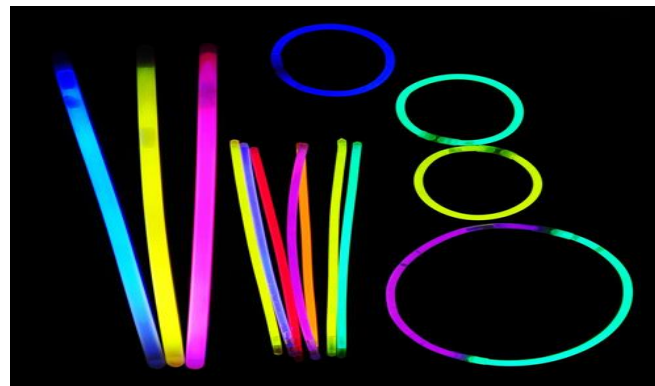


# Chemical Reaction Examples

(needs oxygen and moisture)



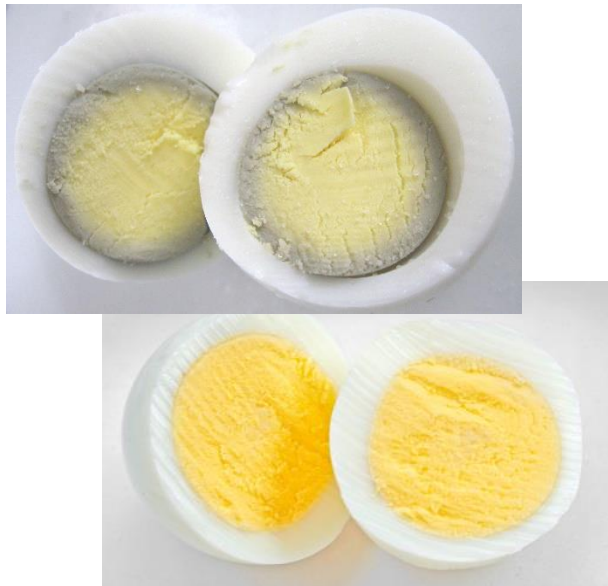
**Rust**: when exposed to “*elements*”, iron develops a red, flaky coating called rust, which is an example of an **oxidation reaction**.



**Glow stick** is a plastic tube with a glass vial inside. When you bend it, the glass vial breaks allowing the chemicals that were inside the glass to mix with the chemicals in the plastic tube. Once these substances combine, a **light-releasing reaction** starts taking place.

# Chemical Reaction Examples

Cleaning with soap:  
soap *emulsifies* grime,  
which means **oily stains**  
**bind to the soap** so they can  
be lifted away with water.

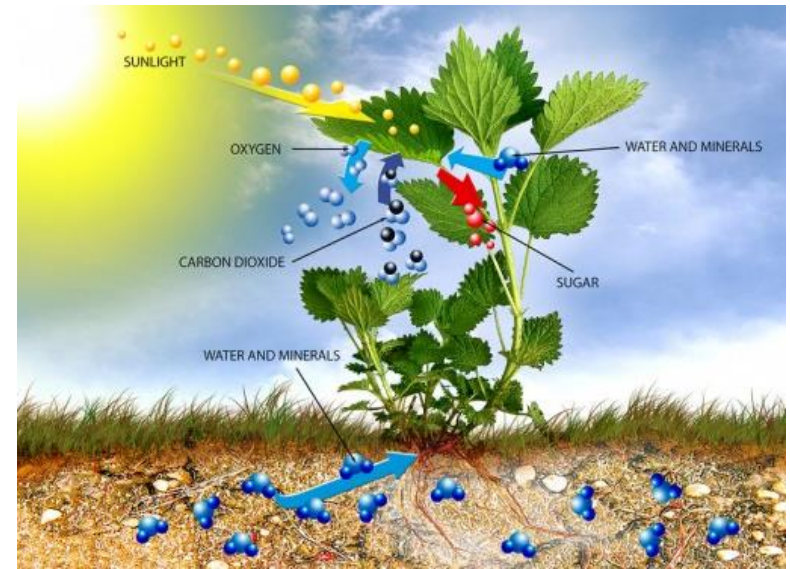


Boiling the egg: when you use **high heat** to boil an egg, it causes a chemical reaction between the yolk and the white that leaves a green film around the yolk. That film is iron sulfide, caused by **iron** in the yolk reacting with **hydrogen sulfide** in the white (*it won't hurt you to eat it, and the egg will taste the same*).

# Chemical Reaction Examples

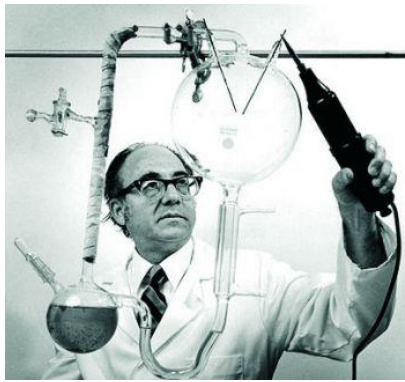


**Combustion**: every time you strike a match, burn a candle, build a fire, or light a grill, you see the combustion reaction; it combines energetic molecules of fuel with oxygen to produce carbon dioxide and water.

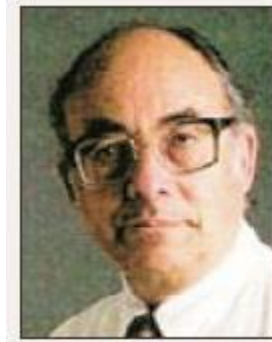


**Photosynthesis**: plants apply a chemical reaction called photosynthesis to convert carbon dioxide and water into food (glucose sugar) and oxygen.





# Miller–Urey experiment, 1953: chemical origins of life

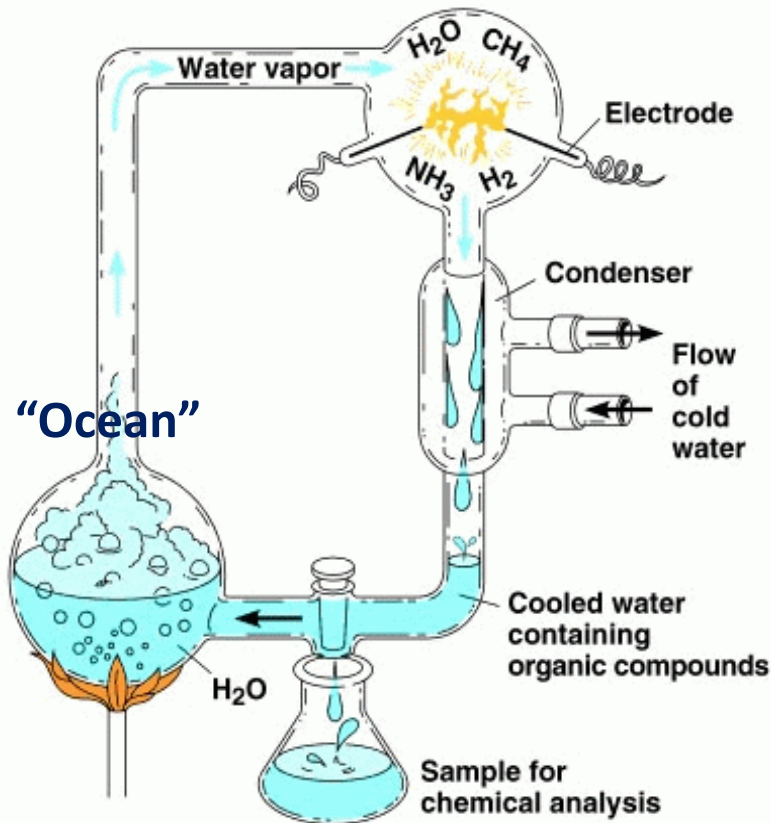


Stanley L. Miller



Harold C. Urey

## “Atmosphere”



- Test for the occurrence of chemical origins of life by simulating the conditions thought at the time to be present on the early Earth.
- The experiment used **water** ( $\text{H}_2\text{O}$ ), **methane** ( $\text{CH}_4$ ), **ammonia** ( $\text{NH}_3$ ), and **hydrogen** ( $\text{H}_2$ ) all sealed inside a sterile loop array of glass flasks; one flask was half-full of **liquid water** (“ocean”) and another flask contained a pair of electrodes. The liquid **water was heated** to induce evaporation, **sparks were fired** between the electrodes to simulate “lightning through the atmosphere” and water vapor; then water could **condense and trickle back** into the first flask in a continuous cycle.
- After two weeks: 10–15% of the carbon was now in the form of **organic compounds**; **>20 amino acids** formed; **sugars** were also formed. However, **nucleic acids were not formed** within the reaction...