Module 4: Describing Chemical and Physical Changes

Submicroscopic Models of Chemical Change

Fundamentals of Chemistry Open Course

Learning Objectives | Module 4

1. Distinguish between chemical and physical changes, particularly in equations containing chemical formulas.

2. Interpret chemical equations to visualize chemical reactions or physical changes.

3. Determine whether a given chemical equation is balanced or not; balance chemical equations.

4. Apply chemical equations to determine the outcome of a chemical reaction on the submicroscopic level.

5. Convert a submicroscopic image of a chemical reaction or physical change into a chemical equation.

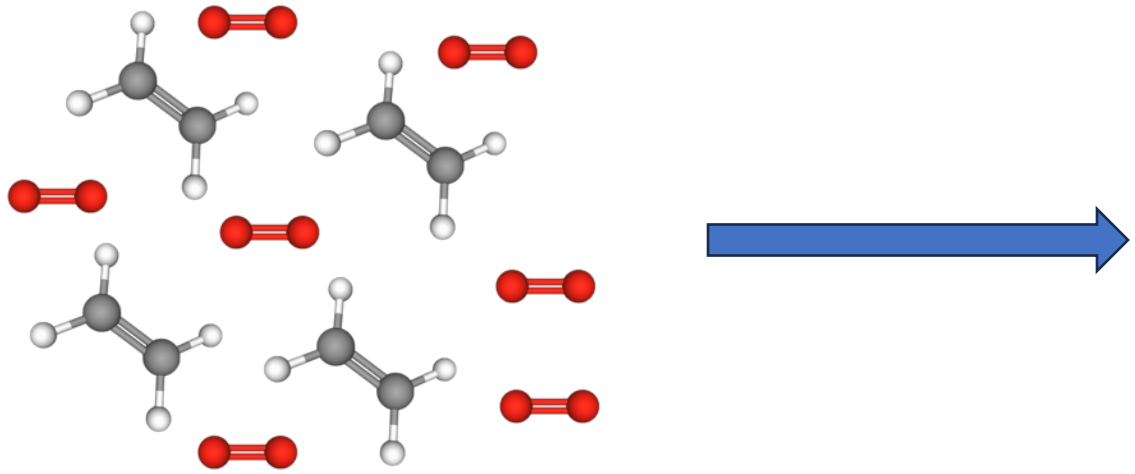
Submicroscopic Models of Chemical Reactions

- When molecules combine in chemical reactions, atoms are conserved. Each **reaction event** takes place in accordance with the balanced chemical equation.

- Using a balanced equation and numbers of reactant molecules, we can work out the composition of a reaction mixture at the end of the reaction.

Example. Ethylene (C_2H_4) reacts with oxygen (O_2) according to the balanced chemical equation below. What is the composition of the reaction mixture at the end of the reaction, given the numbers of molecules in the image?

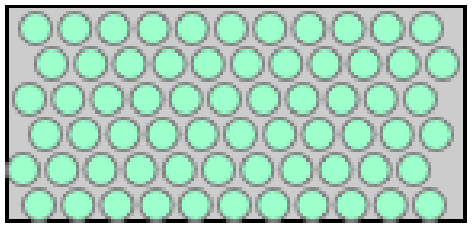
$$C_2H_4(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 2\ H_2O(g)$$



State of Matter in Chemical Equations | 1 of 2

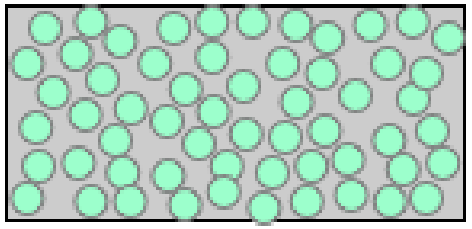
- Phase designators help us visualize each component of a chemical reaction on the macroscopic and submicroscopic levels.

- Recall our submicroscopic models for the solid, liquid, gaseous, and aqueous states.



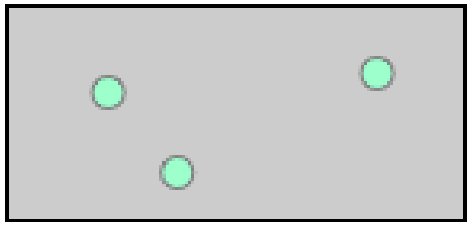
solid

ordered arrangement, molecules in contact



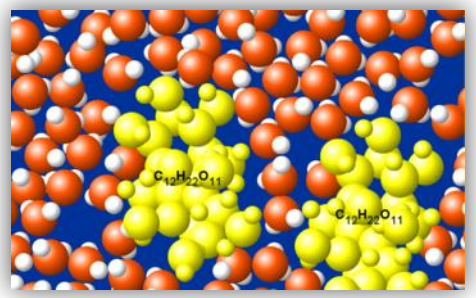
liquid

some disorder, molecules in contact



gas

complete disorder, molecules not in contact



aqueous

solute molecule surrounded by water molecules

- We can use these to visualize changes in the spatial distributions of particles during chemical reactions.

State of Matter in Chemical Equations | 2 of 2

- Phase designators help us visualize each component of a chemical reaction on the macroscopic and submicroscopic levels.

- Phase designators also help us visualize macroscopic chemical change!

Example. The reaction of zinc metal with aqua regia proceeds according to the balanced equation below.

$$2\ Zn(s) + 2\ HCl(aq) + 2\ HNO_3(aq) \rightarrow ZnCl_2(aq) + Zn(NO_3)_2(aq) + 2\ H_2(g)$$

Lingering Questions

- Why do chemical reactions happen? What are the driving forces that govern when and how chemical reactions take place?

- Most chemical reactions occur over two or more collisions between atoms or molecules. How do we think about and study reactions that require multiple steps?