

Module 4: Describing Chemical and Physical Changes

Chemical and Physical Changes

Fundamentals of Chemistry Open Course

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.

Review. Physical and Chemical Changes

- **Physical changes** alter the state or appearance of matter but do not affect its chemical composition.

Melting wax (a) and condensing water (b) are physical changes.



(a)



(b)

- **Chemical changes (chemical reactions)** alter the chemical structure of a substance by breaking and/or forming chemical bonds.

Reaction of iron with oxygen (a) is a chemical change; chromium does not react with oxygen (b).



(a)



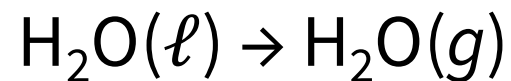
(b)

- **Chemical equations** contain chemical formulas and (usually) phase designators to represent the state of a chemical system before and after some change.

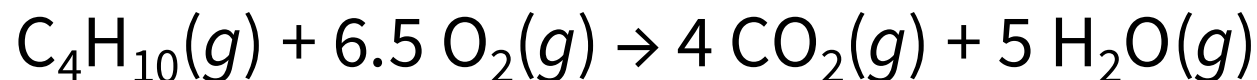
[initial state] → [final state]

- The change may be chemical or physical! Physical changes involve *only* a change in phase designator—chemical formulas do not change.
- Numbers before each chemical formula (**stoichiometric coefficients**) represent the number of formula units involved in the change.
- Coefficients reflect the number ratios in which formula units combine in a chemical reaction.
- Like a recipe, chemical equations can be scaled. In scaling an equation, we multiply all coefficients by the same scaling factor. Chemical formulas remain unchanged!

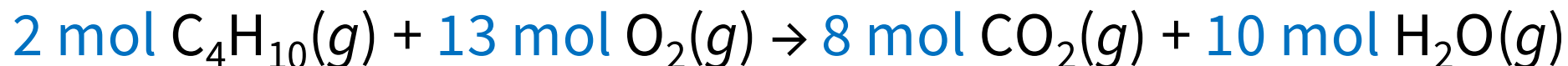
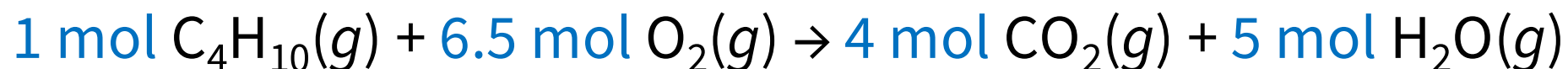
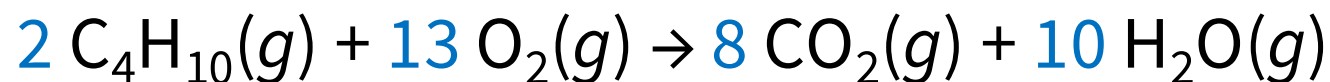
Example. Evaporation of water, a physical change, can be represented as follows.



Example. Combustion of butane (C_4H_{10}) is a chemical change.



This equation can be scaled to any level desired...



- Some chemical substances can react with one another in more than one way. How can we predict the outcome when substances are mixed?
- What makes a chemical equation physically plausible? What natural laws must chemical reactions follow?