

## Carbon and Carbon Compounds

### *Subject Matter and Methodological Competencies*

- name the allotropes of carbon and use them to explain the relationship between its structure and properties
- state the characteristics of the oxides of carbon
- conduct experiments to
  - detect evidence of carbon dioxide
  - detect evidence of carbonates (using carbon dioxide detection)
  - describe the natural formation and decay processes of carbonates and hydrogen carbonates and use this to explain a simple model of the carbon cycle

### **Natural Gas and Crude Oil**

#### *Subject Matter and Methodological Competencies*

- identify natural gas, crude oil and coal as fossil fuels
- explain the causes and consequences of increasing carbon dioxide concentrations in the atmosphere
- discuss the economic and ecological consequences of the production and transport of natural gas and crude oil
- apply knowledge of substance mixtures and substance separation using the example of fractional distillation of petroleum
- describe the molecular structure of the gaseous alkanes using chemical formulas, structural formulas and simplified structural formulas
- conduct experiments to
  - examine the flammability and solubility of selected alkanes
  - determine that water and carbon dioxide are the products of combustion
  - explain the relationship between the construction, properties and uses of important alkanes (e.g. methane - natural gas, propane and butane - liquid gas, octane - gasoline, decane - diesel, octadecane - paraffin candle wax)

- explain the cohesion of alkane molecules by way of van der Waals forces
- name alkanes up to decane, simple branched alkanes, and use the nomenclature system for organic compounds
- compare the construction and properties of isomeric alkanes using an example
- name combustion, substitution and elimination as typical reactions of the alkanes and express them as word equations and chemical equations
- describe the characteristics of a homologous series using the example of alkanes
- describe catalytic cracking and explain the production of gasoline and diesel
- name combustion and addition as typical alkene reactions and express them as word equations and chemical equations
- detect multiple bonds
- perform simple stoichiometric calculations to determine the volume of starting materials and reaction products
- describe the polymerization of ethene and propene
- explain the production, use and recycling of the polymers polyethylene (PE) and polypropylene (PP)
- explain characteristics of reaction types such as substitution, addition and elimination reactions

#### *Social and Emotional Competencies*

- engage with the opinions and views of others and articulate and express one's knowledge of chemistry from one's own point of view
- consciously use knowledge of chemistry to
  - make appropriate decisions in everyday life and behave accordingly
  - appropriately evaluate human interventions in the environment
  - appropriately evaluate practical applications of chemical findings

## Alcohols, Aldehydes und Carboxylic Acids

### Ethanol - An Alcohol

#### *Subject Matter and Methodological Competencies*

- describe the structure, properties and production of ethanol
- identify the hydroxyl group as a functional group
- conduct experiments to
  - examine the flammability and solubility of ethanol
  - compare an ethanol solution and a sodium hydroxide solution
  - explain the cohesion of ethanol molecules by means of the hydrogen bond
  - assess the effects of ethanol (alcohol) as a stimulant and addictive substance
  - describe the structure and uses of other alcohols

### Aldehydes and Carboxylic Acids

#### *Subject Matter and Methodological Competencies*

- explain the catalytic oxidation of ethanol to ethanal and ethanoic acid
- identify the aldehyde group and the carboxyl group as functional groups
- conduct experiments to
  - oxidize a solution of propanol using a copper catalyst
  - detect propanol as an aldehyde by reaction with Schiff's reagent
  - describe the production of ethanoic acid by biocatalysis
  - compare ethanoic acid and hydrochloric acid
  - perform reactions of ethanoic acid with a base metal and a metal hydroxide solution
  - research the occurrence, meaning and use of selected carboxylic acids
  - describe the reaction of alcohols with carboxylic acids to form esters and express these as word equations and chemical equations
  - produce a fruit ester

#### *Social and Emotional Competencies*

- work cooperatively with others in groups
- take responsibility for the outcome of group work
- accept and give help
- communicate in an appropriate and fair way

## Elemental Nitrogen and Nitrogen Compounds

#### *Subject Matter and Methodological Competencies*

- explain the relationship between atomic structure and the position of an element in the periodic table
- derive information about the atomic structure and properties of particles (atom, ion, molecule) of nitrogen from the periodic table
- describe using oxidation numbers the reaction of nitrogen with hydrogen as a redox reaction
- describe the synthesis, properties and uses of ammonia
- explain the countercurrent principle, continuous process control and circulation principle as general technical principles, using the example of the technical implementation of ammonia synthesis
- explain the influence of reaction conditions and the effect of catalysts using the example of ammonia synthesis
- evaluate the historical achievements of Haber and Bosch
- conduct experiments to
  - detect ammonia
  - explain a proton transfer reaction using the reaction of ammonia, water and hydrogen chloride as an example
  - identify bases as proton acceptors and acids as proton donors
  - explain the relationship between atomic structure and the position of an element in the periodic table
  - describe the donor-acceptor principle using as examples known acid-base reactions and illustrate it using chemical notation
  - examine the formation and decay of ammonium chloride
  - create profiles for nitrogen monoxide and nitrogen dioxide
  - explain a redox reaction using the Ostwald process and illustrate using the example of the production of nitric acid
  - explain and apply knowledge of oxidation numbers
  - research the properties and uses of nitric acid
  - compare the properties of concentrated and dilute nitric acid
  - neutralize dilute nitric acid with caustic soda lye
  - explain the characteristics of a chemical reaction, e.g. a neutralization reaction, in terms of
    - substance conversion
    - energy conversion
    - atomic rearrangement
    - breaking and reforming of chemical bonds
  - describe the synthesis, properties and uses of nitrates
  - represent the production route from nitrogen to ammonium nitrate

- explain the characteristics of a redox reaction and reaction with proton transfer using the example of the production of ammonium nitrate from nitrogen
- systematize detection reactions for ions ( $\text{H}_3\text{O}^+$ ,  $\text{OH}^-$ ,  $\text{Ag}^+$ ,  $\text{Ba}^{+2}$ ,  $\text{NH}_4^+$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{SO}_4^{-2}$ ,  $\text{CO}_3^{-2}$ )

#### *Social and Emotional Competencies*

- form personal points of view on chemistry topics, taking into account ecological, social and economic considerations
- carry on a discussion in which one articulates one's own point of view and expresses it in a way that is appropriate to the situation
- consciously use knowledge of chemistry to
  - appropriately make decisions in everyday life and to behave accordingly
  - appropriately evaluate human interventions in the environment