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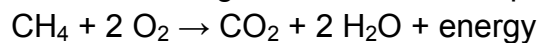
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Chapter 1.Combustion

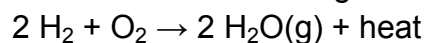
Text I.General introduction

Combustion means reacting with oxygen. The burning of a substance in air is called combustion. Combustion is a form of oxidation. It is the sequence of an exothermic chemical reaction between a substance called fuel and oxidant by the production of heat and conversion of chemical species. The release of heat can result in the production of light in the form either glowing or a flame. Fuels of interest often include organic compounds(especially hydrocarbons) in solid, liquid or gas phase.

In a complete combustion reaction, a compound reacts with an oxidizing element, such as oxygen or fluorine, and the products are compounds of each element in the fuel with the oxidizing element. For example:



A simple example can be seen in the combustion of hydrogen and oxygen, which is a commonly used reaction in rocket engines:



The result is water vapor.

Complete combustion is almost impossible to achieve. In reality, as actual combustion reactions come to equilibrium, a wide variety of major and minor species will be present such as carbon monoxide and pure carbon (soot or ash). Additionally, any combustion in atmospheric air, which is 78% nitrogen, will also create several forms of nitrogen oxides.

Task 1.Text comprehension.

- 1.1.How many chemical elements are mentioned in the text?
- 1.2.Is burning a form of oxidation?
- 1.3.What elements form air?
- 1.4.What does soot consist of?
- 1.5.What kind of reaction is combustion regarding heat?
- 1.6.What are fuels of interest?
- 1.7. What form is water after the combustion of hydrogen in rocket engines?
- 1.8.What kind of light could form?
- 1.9.Can you say that the process of combustion proceeds completely?
- 1.10.Why are nitrogen oxides present in air?

Task 2.How many different nouns are used in the text?

Task 3.Write them down in the order they come in the text.

Task 4. List the examples of the usage of the definite article and comment upon them.

Task 5. Substitute the following words with their synonyms

- ✓ compounds
- ✓ phase
- ✓ element
- ✓ release
- ✓ conversion
- ✓ species

Task 6. Underline the adjectives expressed by nouns.

Text II Incomplete

Incomplete combustion will only occur when there isn't enough oxygen to allow the fuel to react completely to produce carbon dioxide and water. It also happens when the combustion is quenched by a heat sink such as a solid surface or flame trap.

For most fuels, such as diesel oil, coal or wood, pyrolysis occurs before combustion. In incomplete combustion, products of pyrolysis remain unburnt and contaminate the smoke with noxious particulate matter and gases. Partially oxidized compounds are also a concern; partial oxidation of ethanol can produce harmful acetaldehyde, and carbon can produce toxic carbon monoxide.

The quality of combustion can be improved by design of combustion devices, such as burners and internal combustion engines. Further improvements are achievable by catalytic after-burning devices (such as catalytic converters) or by the simple partial return of the exhaust gases into the combustion process. Such devices are required by environmental legislation for cars in most countries, and may be necessary in large combustion devices, such as thermal power plants, to reach legal emission standards.

The degree of combustion can be measured and analyzed, with test equipment. HVAC contractors, firemen and engineers use combustion analyzers to test the efficiency of a burner during the combustion process. In addition, the efficiency of an internal combustion engine can be measured in this way, and some states and local municipalities are using combustion analysis to define and rate the efficiency of vehicles on the road today.

Task 1. Text III comprehension

- 1.1. What is the essence of incomplete combustion?
- 1.2. Name the products of partial oxidation.
- 1.3. What products remain unburnt?

- 1.4. How is the quality of combustion improved?
- 1.5. What is meant by large combustion devices?
- 1.6. What combustion devices we use every day?
- 1.7. Why are after-burning devices required by legislation?
- 1.8. What particular branch of legislation is it?
- 1.9. What is the name of the device used in analyzing combustion?
- 1.10. Why is the analysis of internal combustion engine necessary?

Task 2.Explain the meaning of the following word combinations in English

- ✓ quenched
- ✓ heat sink
- ✓ noxious
- ✓ device
- ✓ efficiency
- ✓ vehicles

Task 3.Substitute synonyms for the following words

- ✓ rate
- ✓ sink
- ✓ trap

Task 4.Put the right adjective before the correct noun

Solid	legislation
Emission	devices
Catalytic	standards
Environmental	converters
Combustion	surface

Task 5.Write the chemical formulas of acetaldehyde and carbon monoxide.

Task 6.Define incomplete combustion in your own words.

Task 7.Find the meaning of the abbreviation HVAC.

Text IV. Smoldering

Smoldering is the slow, low-temperature, flameless form of combustion, sustained by the heat evolved when oxygen directly attacks the surface of a condensed-phase fuel. It is a typically incomplete combustion reaction. Solid materials that can sustain a smoldering reaction include coal, cellulose, wood,

cotton, tobacco, peat, duff, humus, synthetic foams, charring polymers including polyurethane foam, and dust. Common examples of smoldering phenomena are the initiation of residential fires on upholstered furniture by weak heat sources (e.g., a cigarette, a short-circuited wire), and the persistent combustion of biomass behind the flaming front of wildfires

Task 1. Text IV comprehension

- 1.1. is specific of smoldering?
- 1.2. What materials can smolder?
- 1.3. How can you explain condensed-phase fuels?
- 1.4. Name the examples of smoldering?

Task 2. Find the translation of the following words in Latvian

- ✓ peat
- ✓ duff
- ✓ humus
- ✓ foam
- ✓

Task 3. Detect the part of speech in the word smoldering (headline) and in a word combination a smoldering reaction.

Task 4. Underline the prepositions in the text.

Task 5. Detect whether they are place or time prepositions.

Text V. Burn rate

In chemistry, the burn rate (or burning rate) is a measure of the linear combustion rate of a compound or substance such as a candle or a solid propellant. Burn rate is measured in length over time, such as “mm/second” or “inches/second”. Burn rate is a property of combustible substance and it quantifies the combustion rates. Burn rates can be measured and are different for a given substance at different pressures (equal to, above or below ambient pressure). Burning rate typically increases with pressure and temperature. There are few exceptions in which the burn rates are either neutral (e.g. black powder) or varies inversely with pressure. A substance is characterized through burn rate vs pressure chart and burn rate vs temperature chart.

One apparatus for measuring burning rate is a V shaped metal channel about 1-2 feet long wherein a sample is placed, with a cross-sectional dimension of approximately 6 mm or 1/4”. The sample is ignited on one end and time is measured until the flame front gets to the other end. Burn rate (typically expressed in “mm/s” or “in/s”) is the sample length over time at a

given pressure and temperature. For solid propellant the most common method of measuring burn rate is the Crawford Type Strand Burning Rate Bomb System, also known as the Crawford Burner or Strand Burner.

If a sample burns at a rate in excess of Mach 1 or 1,138 feet per second (347m/s), it is called detonation. If a sample burn rate is in few meters per second, it is called deflagration. If a sample burn rate is few centimetres per second, it is generally understood that the sample neither detonates or deflagrates, but rather burns or smolders . Between the range of 0.01mm/s and 100mm/s most scientists agree the sample is burning not deflagrating on the basis that deflagrating uses the term decomposes rapidly to characterize it. However, there is difference in opinion in differetiating the three in absence of firm numbers at given pressure or temperature.

Task 1. Text V comprehension

- 1.1.Is a burn rate a constant value?
- 1.2.How can a burn rate be measured?
- 1.3.How can a substance be characterized?
- 1.4.Do all substances react in the same way?
- 1.5.How is the burn rate expressed quantitatively?
- 1.6.what is the most popular apparatus for measuring burn rates?
- 1.7.What is detonation?
- 1.8.What is deflagration?
- 1.9.Describe the procedure of measuring a burn rate.
- 1.10.What does the abbreviation Mach stand for?
- 1.11.What is meant by ambient pressure?

Task 2. Underline the conjunctions in the sentences.

Task 3. Find the prepositions which are used with the gerund.

Task 4. Describe the meaning of the homonyms.

- ✓ channel
- ✓ firm
- ✓ pressure

Task 5.What is the symbol of a half inch?

Text 6.Microgravity and Microcombustion

Combustion resulting in a turbulent flame is the most used for industrial application (e.g. gas turbines, gasoline engines, etc.) because the turbulence helps the mixing process between the fuel and oxidizer.

Combustion processes behave differently in a microgravity environment than in Earth-gravity conditions due to the lack of buoyancy. For example, a

candle's flame takes the shape of a sphere.

Combustion processes which happen in very small volume are considered as micro combustion. Quenching distance plays a vital role in stabilizing the flame in such combustion chambers.

Nitrogen may also oxidize when there is an excess of oxygen. The reaction is thermodynamically favored only at high temperatures. Diesel engines are run with an excess of oxygen to combust small particles that tend to form with only a stoichiometric amount of oxygen, necessarily producing nitrogen oxide emissions. Both the United States and European Union are planning to impose limits to nitrogen oxide emissions, which necessitate the use of a special catalytic converter or treatment of the exhaust with urea.

Task 1. TextVI comprehension.

- 1.1. Where is turbulence used?
- 1.2. Why is combustion different in a microgravity environment?
- 1.3. What shape is a candle's flame in the above mentioned environment?
- 1.4. Why is microgravity combustion researched?
- 1.5. What is the name of combustion in very small volume?
- 1.6. How can the flame be stabilized in small volume?
- 1.7. Can nitrogen become an oxidizing agent?
- 1.8. What is the application of excess oxygen?
- 1.9. What is a stoichiometric amount of oxygen?
- 1.10. Why do we need to avoid nitrogen oxide fumes?
- 1.11. What can be done?

Task 2. Underline the adverbs in the text?

Task 3. Explain the meaning of run in the text?

Task 4. Form different parts of speech with the words

- ✓ buoyancy
- ✓ excess
- ✓ catalytic

Task 5. Find the relative pronouns in the text.

Combustion of a liquid fuel in an oxidizing atmosphere actually happens in the gas phase. It is the vapour that burns, not the liquid. Therefore, a liquid will normally catch fire only above a certain temperature: its flash point. The flash point of a liquid fuel is the lowest temperature at which it can form an ignitable mix with air. It is also the minimum temperature at which there is enough evaporated fuel in the air to start combustion.

Text VII. Solid fuels

The act of combustion consists of three relatively distinct but overlapping phases:

- ✓ **Preheating phase**, when the unburned fuel is heated up to its flash point and then fire point. Flammable gases start being evolved in a process similar to dry distillation.
- ✓ **Distillation phase** or **gaseous phase**, when the mix of evolved flammable gases with oxygen is ignited. Energy is produced in the form of heat and light. Flames are often visible. Heat transfer from the combustion to the solid maintains the evolution of flammable vapours.

Charcoal phase or **solid phase**, when the output of flammable gases from the material is too low for persistent presence of flame and the charred fuel does not burn rapidly anymore but just glows and later only smoulders.

Task 1. Text VII comprehension.

- 1.1. What really burns in a liquid phase?
- 1.2. Define a flash point.
- 1.3. What is the minimum temperature for?
- 1.4. Is the flash point the highest temperature for igniting the mix?
- 1.5. What solid fuels can you name?
- 1.6. What are the three phases of combustion of solid fuels?
- 1.7. What do flammable gases do during the preheating phase?
- 1.8. What do flammable gases do during the distillation phase?
- 1.9. What do flammable gases do during the charcoal phase?
- 1.10. When are flames visible?
- 1.11. What evolves during the distillation phase?
- 1.12. What does the charred fuel do?
- 1.13. What energy forms are mentioned?
- 1.14. What is the mix?

Task 2. Substitute the following words with the synonyms

- ✓ output
- ✓ charred
- ✓ evolution
- ✓ evaporated

Chapter 2. Laboratory technique

Text I. Laboratory glassware refers to a variety of equipment, traditionally made of glass, used for scientific experiments and other work in science, especially in chemistry and biology laboratories. Some of the equipment is now made of plastic for cost, ruggedness, and convenience reasons, but glass is still used for some applications because it is relatively inert, transparent, more heat-resistant than some plastics up to a point, and relatively easy to customize. Borosilicate glasses—formerly called Pyrex—are often used because they are less subject to thermal stress and are common for reagent bottles. For some applications quartz glass is used for its ability to withstand high temperatures or its transparency in certain parts of the electromagnetic spectrum. In other applications, especially some storage bottles, darkened brown or amber (actinic) glass is used to keep out much of the UV and IR radiation so that the effect of light on the contents is minimized. Special-purpose materials are also used; for example, hydrofluoric acid is stored and used in polyethylene containers because it reacts with glass. For pressurized reaction, heavy-wall glass is used for pressure reactors.

Task 1. Text I comprehension

- 1.1. What is laboratory glassware?
- 1.2. Why is it needed?
- 1.3. Why is plastic sometimes used?
- 1.4. What are the advantages of glass?
- 1.5. What is the composition of Pyrex?
- 1.6. What glass is used in heating?
- 1.7. What colour are storage bottles?
- 1.8. What are the advantages of quartz glass?
- 1.9. Which rays are kept out of storage bottles?
- 1.10. When cannot glass be used?
- 1.11. What glass is used for pressure reactors?

Task 2. Find one-syllable adjectives in the text.

Task 3. Explain the meaning of the following words in English

- ✓ inert
- ✓ transparent
- ✓ amber

Task 4. Translate the following phrases into Latvian

- ✓ to be subject to
- ✓ to keep out
- ✓ to withstand
- ✓ to customize

Task 5. Form your own sentences using words from task 4.**Task 6. Note two – word adjectives in the text.****Task 7. How many adjectives are formed by nouns?****Task 8. Discuss the difference between the words**

Text II. Applications

There are many different kinds of laboratory glassware items. Such glassware is used for a wide variety of functions which include volumetric measuring, holding or storing chemicals or samples, mixing or preparing solutions or other mixtures, containing lab processes like chemical reactions, heating, cooling, distillation, separations including chromatography, synthesis, growing biological organisms, spectrophotometry, and containing a full or partial vacuum, and pressure, like pressure reactor. When in use, laboratory glassware is often held in place with clamps made for that purpose, which are likewise attached and held in place by stands or racks. Laboratory glassware is various and is used for different purposes. It is usually kept on the shelves or on the racks along the walls of the laboratory, but some of it may be kept on the table for the tasks at hand. Vials and tubes are used for keeping liquids at room temperature, but porcelain dishes are convenient when heating is needed. Beakers of different size, conical and round flasks help laboratory staff prepare various solutions. Graduated cylinders and volumetric flasks are of great help in measuring volume. Pipettes are used for carrying small amounts of liquids from one jar to another jug. Funnels are necessary for filtering substances. Mortars and pestles, which are usually made of porcelain, are used for grinding solid substances into powder or suspension. Bunsen burners provide heat for inducing thermal reactions.

Task 1. Text II comprehension.

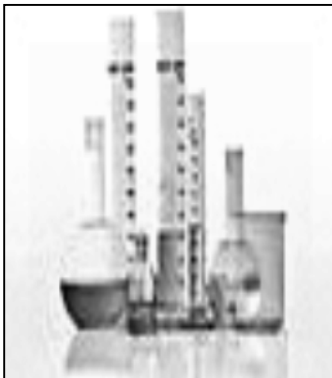
- 1.1. What chemical processes are mentioned in the text?
- 1.2. What glassware items are noted in the text?
- 1.3. What is a difference between a vial and a tube?
- 1.4. What porcelain items are mentioned in the text?
- 1.5. Is a beaker only one size?
- 1.6. What items are used for measuring volume?
- 1.7. What is the function of pipettes?
- 1.8. Where are funnels used?
- 1.9. What fuel is used in Bunsen burners?
- 1.10. Name the functions of glassware.

Task 2. Underline the nouns in the text.

Task 3. State which nouns are singular and which are plural.

Task 4. Which nouns can be used as adjectives in the same form?

Picture 1. Items of glassware



Task 1. Describe the picture 1.

Task 2. How many graduated cylinders are there?

Task 3. How many round flasks are there?

Task 4. How many porcelain beakers are there?

Picture 2. Variety of glassware.



Task 1. Describe the picture 2.

Task 2. Use the prepositions next to, behind describing the picture.

Picture 3. Glass jugs and bottles.



Task 1. Describe the picture 3.

Task 2. Discuss the functions they are used for.

Text III. Titration

Titration, also known as **titrimetry**, is a common laboratory method of quantitative chemical analysis that is used to determine the unknown concentration of a known reactant. Because volume measurements play a key role in titration, it is also known as **volumetric analysis**. A reagent, called the *titrant* or *titrator*, of a known concentration (a standard solution) and volume is used to react with a solution of the analyte or *titrand*, whose concentration is not known. Using a calibrated burette or chemistry pipetting syringe to add the titrant, it is possible to determine the exact amount that has been consumed when the *endpoint* is reached. The endpoint is the point at which the titration is complete, as determined by an indicator (see below). This is ideally the same volume as the equivalence point—the volume of added titrant at which the number of moles of titrant is equal to the number of moles of analyte, or some multiple thereof (as in polyprotic acids). In the classic strong acid-strong base titration, the endpoint of a titration is the point at which the pH of the reactant is just about equal to 7, and often when the solution takes on a persisting solid color as in the pink of phenolphthalein indicator. There are however many different types of titrations (see below).

Many methods can be used to indicate the endpoint of a reaction; titrations often use visual indicators (the reactant mixture changes color). In simple acid-base titrations a pH indicator may be used, such as phenolphthalein, which becomes pink when a certain pH (about 8.2) is reached or exceeded. Another example is methyl orange, which is red in acids and yellow in alkali solutions.

Not every titration requires an indicator. In some cases, either the reactants or the products are strongly colored and can serve as the "indicator". For example, a redox titration using potassium permanganate (pink/purple) as the titrant does not require an indicator. When the titrant is reduced, it turns colorless. After the equivalence point, there is excess titrant present. The equivalence point is identified from the first faint persisting pink color (due to an excess of permanganate) in the solution being titrated.

Due to the logarithmic nature of the pH curve, the transitions are, in general, extremely sharp; and, thus, a single drop of titrant just before the *endpoint* can change the pH significantly—leading to an immediate color change in the indicator. There is a slight difference between the change in indicator color and the actual equivalence point of the titration. This error is referred to as an indicator error, and it is indeterminate.

Task 1. Text IV comprehension

- 1.1. What is the purposes of titration?
- 1.2. Whose concentration is known?
- 1.4. What are the synonyms for standard solutions?
- 1.5. What is the end point?
- 1.6. What is the difference between the endpoint and the equivalence point?
- 1.7. What is the classic titration?
- 1.8. Name the indicators used in the titration process.
- 1.9. What does an indicator do during the titration process?
- 1.10. Does every titration need an indicator?
- 1.11. What is pH curve like?
- 1.12. What is an indicator error?

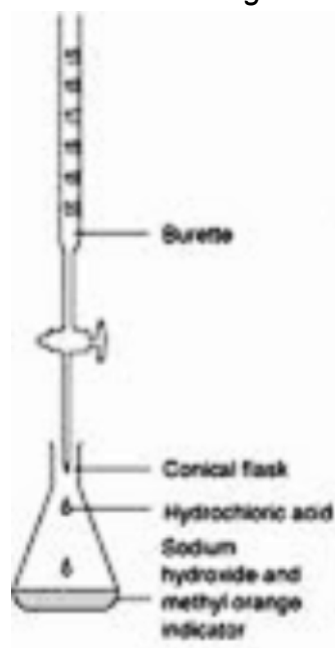
Task 2. Find the meanings of homonyms

- ✓ mole
- ✓ concentration
- ✓ acid-strong

Task 3. Underline the word pairs indicating the process being done.

Task 4. Are there any other endings indicating the action from both sides?

Picture 4. Titrating sodium hydroxide and hcl.

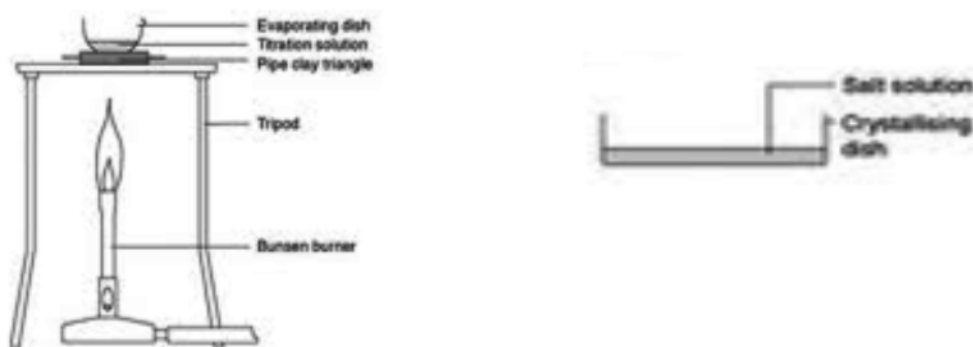


Task 1. What is hcl?

Task 2. Use place prepositions describing the picture 4.

- 1.1. Where is the burette?
- 1.2. Where is hcl solution?
- 1.3. Where is an evaporating dish?
- 1.4. Where is the clay triangle?
- 1.5. Where is the Bunsen burner?
- 1.6.1. Where is a crystallising dish?
- 1.6.2. Where is a crystallising dish?
- 1.7.1. Where is the tripod?
- 1.7.1. Where is the tripod?
- 1.8.1. Where is the burette?
- 1.8.2. Where is the burette?

Text IV Filtration



Filtration is commonly the mechanical or physical operation which is used for the separation of solids from fluids (liquids or gases) by interposing a medium through which only the fluid can pass. Oversize solids in the fluid are retained, but the separation is not complete; solids will be contaminated with some fluid and filtrate will contain fine particles (depending on the pore size and filter thickness). Filtration is also used to describe some biological processes, especially in water treatment and sewage treatment in which undesirable constituents are removed by adsorption into a biological film grown on or in the filter medium.

Applications

- ✓ Filtration is used to separate particles and fluid in a suspension, where the fluid can be a liquid, a gas or a supercritical fluid. Depending on the application, either one or both of the components may be isolated.
- ✓ Filtration, as a physical operation is very important in chemistry for the separation of materials of different chemical composition. A solvent is chosen which dissolves one component, while not dissolving the other. By dissolving the mixture in the chosen solvent, one component will go into the solution and pass through the filter, while the other will be retained.

This is one of the most important techniques used by chemists to purify compounds.

- ✓ Filtration is also important and widely used as one of the unit operations of chemical engineering. It may be simultaneously combined with other unit operations to process the feed stream, as in the biofilter, which is a combined filter and biological digestion device.
- ✓ Filtration differs from sieving, where separation occurs at a single perforated layer (a sieve). In sieving, particles that are too big to pass through the holes of the sieve are retained (see particle size distribution). In filtration, a multilayer lattice retains those particles that are unable to follow the tortuous channels of the filter.[1] Oversize particles may form a cake layer on top of the filter and may also block the filter lattice, preventing the fluid phase from crossing the filter (blinding). Commercially, the term filter is applied to membranes where the separation lattice is so thin that the surface becomes the main zone of particle separation, even though these products might be described as sieves.[2]
- ✓ Filtration differs from adsorption, where it is not the physical size of particles that causes separation but the effects of surface charge. Some adsorption devices containing activated charcoal and ion exchange resin are commercially called filters, although filtration is not their principal function.[3]
- ✓ Filtration differs from removal of magnetic contaminants from fluids with magnets (typically lubrication oil, coolants and fuel oils), because there is no filter medium. Commercial devices called "magnetic filters" are sold, but the name reflects their use, not their mode of operation.[4] edit] Filter media

It has been suggested that Filter (chemistry) be merged into this article or section. (Discuss) *Proposed since March 2011.*

Two main types of filter media are employed in the chemical laboratory—**surface filter**, a solid sieve which traps the solid particles, with or without the aid of filter paper (e.g. Büchner funnel, Belt filter, Rotary vacuum-drum filter, Cross-flow filters, Screen filter), and a **depth filter**, a bed of granular material which retains the solid particles as it passes (e.g. sand filter). The first type allows the solid particles, i.e. the residue, to be collected intact; the second type does not permit this. However, the second type is less prone to clogging due to the greater surface area where the FILTRATION

This is a method which is the most especially effective for separating suspensions, for example mud in water. We pour the mixture into a funnel fitted with a piece of filter paper. There are tiny holes in the filter paper for the liquid to pass through, the solid particles are too large to do so, therefore the solid particles will stay on the paper as what we called a solid residue. We called the liquid which pass through the FILTRATE.

There are two ways of folding the filter paper for the filtration:

Fold the paper in half along one diameter then in quarters.

Fold a fluted filter paper. Fold the paper in half, then open out, after that fold in the same direction at a right angles to the original. Fold the paper two more times, the folds being all the same direction and mutually at around 45 degrees. Each section will then individually folded in the opposite direction. As result is a 'FLUTED' which sixteen faces will be produced. It provide a faster rate of filtration.

FILTRATION is widely used in industry. Beer is separated from its sediment.

Tap water has also been filtered through filter beds to remove solid impurities.

Task 1. Text V comprehension

- 1.1. Is filtration a chemical operation?
- 1.2. What is the purpose of filtration?
- 1.3. Can the filtered fluid be completely clean?
- 1.4. What is different in filtration of sewage waters?
- 1.5. How many applications of filtration can you name?
- 1.6. What is a biofilter?
- 1.7. What is different in sieving?
- 1.8. How thick is a membrane?
- 1.9. What is the difference between filtration and adsorption?
- 1.10. What are magnetic filters?
- 1.11. Is there only one method of filtration?
- 1.12. What types of filter can you name?
- 1.13. What are the subtypes of surface filters?
- 1.14. What is the most common method of filtration?
- 1.15. What is filtrate?
- 1.16. What is the other word for mixture?
- 1.17. Where do we use filtration in every day life?
- 1.18. What must be done to the filter paper?
- 1.19. Why should filter paper be fluted?
- 1.20. Are you able to fold the filter paper in flutes?

Task 2. Find the synonyms of the following words in the text

- ✓ fluid
- ✓ mixture
- ✓ components
- ✓ film
- ✓ block

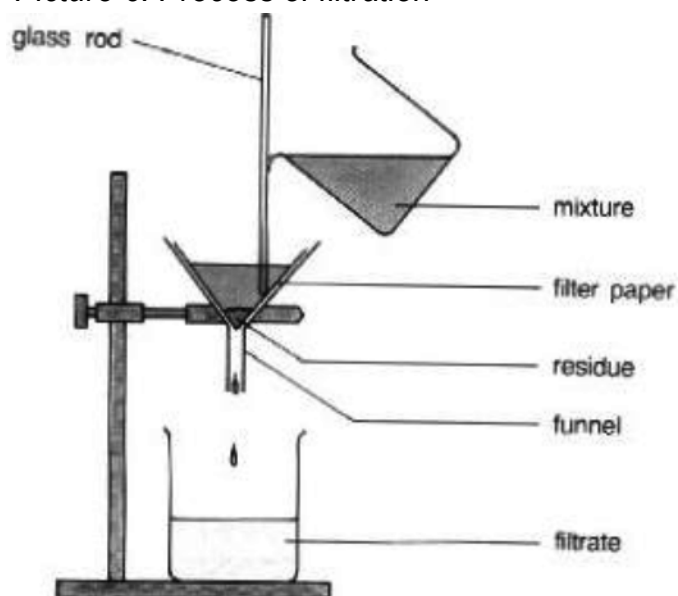
Task 3. Analyze the meaning of the homonyms

- ✓ solvent
- ✓ Lattice

Task 4. What are the antonyms of the following words

- ✓ oversize
- ✓ dissolve
- ✓ multilayer
- ✓ intact
- ✓ depth.

Picture 6. Process of filtration



Task 5. Describe the picture using the place prepositions

- ✓ on
- ✓ above
- ✓ under
- ✓ in
- ✓ next to

Task 6. Describe the picture using the preposition combinations

- ✓ at the top
- ✓ in the middle
- ✓ at the bottom
- ✓ Chapter 3Bases

Text I. Definitions

A base in chemistry is a substance that can accept hydrogen ions or more generally, donate electron pairs. A soluble base is referred to as an alkali if it contains and releases hydroxide ions (OH^-) quantitatively. The Brønsted-Lowry theory defines bases as proton (hydrogen ion) acceptors, while the more general Lewis theory defines bases as electron pair donors, allowing other Lewis acids than protons to be included. The oldest Arrhenius theory defines bases as hydroxide anions, which is strictly applicable only to alkali. In water, by altering the autoionization equilibrium, bases give solutions with a hydrogen ion activity lower than that of pure water, i.e. a pH higher than 7.0 at standard conditions. Examples of common bases are sodium hydroxide and ammonia. Metal oxides, hydroxides and especially alkoxides are basic, and counter ions of weak acids are weak bases. A strong base is a base which hydrolyzes completely, raising the pH of the solution toward 14. Concentrated bases, like concentrated acids, attack living tissue and cause serious burns. The reaction of bases upon contact with skin is different from that of acids. So while either may be quite destructive, strong acids are called edit, and strong bases are referred to as caustic. Superbases are a class of especially basic compounds and non-nucleophilic bases are a special class of strong bases with poor nucleophilicity. Bases may also be weak bases such as ammonia, which is used for cleaning. **Arrhenius bases** are water-soluble and these solutions always have a pH greater than 7 at standard conditions. An alkali is a special example of a base, where in an aqueous environment, hydroxide ions are donated.

The notion of a base as a concept in chemistry was first introduced by the French chemist Guillaum François Rouelle in 1754. He noted that acids, which in those days were mostly volatile liquids (like acetic acid), turned into solid salts only when combined with specific substances. Rouelle considered that such a substance serves as a base for the salt, giving the salt a "concrete form.

Bases can be thought of as the chemical opposite of acids. A reaction between an acid and base is called neutralization. Bases and acids are seen as opposites because the effect of an acid is to increase the hydronium ion (H_3O^+) concentration in water, whereas bases reduce this concentration. Bases and acids are typically found in aqueous solution forms. Aqueous solutions of bases react with aqueous solutions of acids to produce water and salts in aqueous solutions in which the salts separate into their component ions. If the aqueous solution is a saturated solution with respect to a given salt solute any additional such salt present in the solution will result in formation of a precipitate of the salt.

Task 1. Text I comprehension

- 1.1. What theories define bases?
- 1.2. What does a word soluble mean?
- 1.3. Which substances are basic?
- 1.4. How large is hydrogen ion activity in bases' water solutions?
- 1.5. What is the pH number in bases' solutions?
- 1.6. Which are the most common bases?
- 1.7. What are the opposites of bases?
- 1.8. Which chemical substance increase the concentration of hydronium ion?
- 1.9. What is the synonym of aqueous?
- 1.10. What is the result of reactions between bases and acids?
- 1.11. What does a term saturated solution mean?
- 1.12. What does additional salt in solutions do?
- 1.13. What is characteristic of a strong base?
- 1.14. Define a superbase.
- 1.15. What is specific in alkali?
- 1.16. Name the most common usage of weak bases.
- 1.17. What did Monsignor Rouelle notice?

Task 2. What is the difference between a basis and a base?

Task 3. What is the modern usage of a basis and a base?

Task 4. Find the meaning of the homonyms

- ✓ present
- ✓ produce
- ✓ solution

Task 5. Give the full versions of the short versions of the words

- ✓ solute
- ✓ precipitate

Task 6. Give the synonyms for the words

- ✓ alter
- ✓ water
- ✓ equilibrium

Text II.Properties

Some general properties of bases include:

- ✓ Slimy or soapy feel on fingers, due to saponification of the lipids in human skin.
- ✓ Concentrated or strong bases are caustic on organic matter and react violently with acidic substances.
- ✓ Aqueous solutions or molten bases dissociate in ions and conduct electricity.
- ✓ Reactions with indicators: bases turn red litmus paper blue, phenolphthalein pink, keep bromothymol blue in its natural colour of blue, and turns methyl orange yellow.
- ✓ The pH level of a basic solution is higher than 7.
- ✓ Bases are bitter in taste.

Task 1.Text II comprehension

- 1.1. What do feel when you touch a base?
- 1.2. Why is such a feeling possible?Alkalinity is a measure of the ability of a solution to neutralize acids to the equivalence points of carbonates or bicarbonates.
- 1.3. Do bases react with organic substances?
- 1.4. What does the term caustic mean?
- 1.5. What can aqueous solutions of bases dissolve in?
- 1.6. What properties molten bases possess?
- 1.7. What colour are the indicators after reacting with solutions of bases?
- 1.8. What is the pH level?
- 1.9. Do bases taste sweet?
- 1.10. How can you prove basic properties?

Task 2.Form relative sentences using the conjunction which and the adjectives

- ✓ slimy
- ✓ bitter
- ✓ coloured

Text III.Bases and pH

The pH of an aqueous sample (water) is a measure of its acidity. In pure water, about one in ten million molecules dissociate into hydronium ions and hydroxide ions according to the following equation:



The concentration, measured in molarity (M or moles per litre), of the ions is indicated as $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$; their product is the dissociation constant of water and has the value of $10^{-14} M^2$. The pH is defined as $-\log [\text{H}_3\text{O}^+]$; thus, pure water has a pH of 7. (These numbers are correct at 23 °C and are slightly different at other temperatures.)

A base accepts (removes) hydronium ions from the solution, or donates hydroxide ions to the solution. Both actions will lower the concentration of hydronium ions, and thus raise pH. By contrast, an acid donates H_3O^+ ions to the solution or accepts OH^- , thus lowering pH.

For example, if 1 mole (40 g) of sodium hydroxide (NaOH) is dissolved in water to make 1 litre of solution, the concentration of hydroxide ions becomes $[\text{OH}^-] = 1 \text{ mol/L}$. As the ionic product remains a constant value, $[\text{H}^+] = 1 \times 10^{-14} / [\text{OH}^-] = 1 \times 10^{-14} \text{ mol/L}$, and $\text{pH} = -\log 10^{-14} = 14$. Note that in this calculation, it is assumed that the activity is equivalent to the concentration, which is not realistic at concentrations over 0.1 mol/L.

The base dissociation constant, K_b , is a measure of basicity. It is related to the acid dissociation constant, K_a , by the simple relationship $\text{p}K_a + \text{p}K_b = 14$, where $\text{p}K_b$ and $\text{p}K_a$ are the negative logarithms of K_b and K_a , respectively.

Alkalinity is a measure of the ability of a solution to neutralize acids to the equivalence points of carbonates or bicarbonates.

Task 1. Text III comprehension.

- 1.1. What is the definition of pH?
- 1.2. What process take place in pure water?
- 1.3. What is the quantitative expression of concentration?
- 1.4. Is pH affected by temperature?
- 1.5. Can the dissociation constant change?
- 1.6. What can a base do?
- 1.7. How can one raise the level of pH?
- 1.8. What does an acid do?
- 1.9. How can one lower the level of pH?
- 1.10. Is the ionic product always the same?
- 1.11. Is the concentration equal to activity?
- 1.12. What is a measure of basicity?
- 1.13. How can you define alkalinity?

Task 2. Find the synonyms for the following words

- ✓ Donate
- ✓ Remain
- ✓ Assume
- ✓ Slightly
- ✓ Constant

Task 3. Find the examples of the Passive Voice in the text.

Task 4. State the tense.

Task 5. What is the difference between pure and clear?

Task 6. What are other meanings of the homonym mole?

Task 7. Write down cardinal numbers as they are spoken.

Text IV. Measures of Alkalinity

Alkalinity of non-hydroxides

Bases are generally compounds that can neutralize an amount of acids. Both sodium carbonate and ammonia are bases, although neither of these substances contains OH^- groups.

Carbon can act as a base as well as nitrogen and oxygen. This occurs typically in compounds such as butyl lithium, alkoxides, and metal amides such as sodium amide. Bases of carbon, nitrogen and oxygen without resonance stabilization are usually very strong, or superbases, which cannot exist in a water solution due to the acidity of water. Resonance stabilization, however, enables weaker bases such as carboxylates; for example, sodium acetate is a weak base.

Strong bases

A strong base is a basic chemical compound that is able to deprotonate very weak acids in an acid-base reaction. Common examples of strong bases are the hydroxides of alkali metals and alkaline earth metals like NaOH and $\text{Ca}(\text{OH})_2$. Very strong bases are even able to deprotonate very weakly acidic C–H groups in the absence of water. We can name several strong bases such as potassium hydroxide, sodium hydroxide and barium hydroxide.

The cations of these strong bases appear in the first and second groups of the periodic table (alkali and earth alkali metals).

Acids with a $\text{p}K_a$ of more than about 13 are considered very weak, and their conjugate bases are strong bases.

Bases as catalysts

Basic substances can be used as insoluble heterogeneous catalysts for chemical reactions. Some examples are metal oxides such as magnesium oxide, calcium oxide, and barium oxide as well as potassium fluoride on alumina and some zeolites. Many transition metals make good catalysts, many of which form basic substances. Basic catalysts have been used for hydrogenations, the migration of double bonds, in the Meerwein-Ponndorf-Verley reduction, the Michael reaction, and many other reactions.

Task 1. Text IV comprehension

- 1.1. Do all bases contain hydroxyl groups?
- 1.2. Which substances contain nitrogen as a base?
- 1.3. Are non-hydroxides strong bases?
- 1.4. Can superbases exist in water solution?
- 1.5. How can one define a strong base?
- 1.6. Is water necessary for deprotonating?
- 1.7. Which groups of the periodical table are the cations of strong bases in?
- 1.8. Where are basic substances used?
- 1.9. Are they soluble when used as catalysts?
- 1.10. Which are the most popular catalysts?
- 1.11. What reactions are basic catalysts applied in?

Task 2. Write the chemical formulas of strong bases .

Task 3. Explain the meaning of the following words in English

- ✓ Conjugate
- ✓ Catalyst

Task 4. Find the uncountable nouns in the text.

Task 5. Underline the nouns with the definite article.

Chapter 4.Acids

Text I. The concept of acids

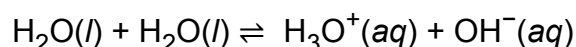
Common examples of acids include acetic acid (in vinegar), sulfuric acid (used in car batteries), and tartaric acid (used in baking). As these three examples show, acids can be solutions, liquids, or solids. Gases such as hydrogen chloride can be acids as well. Strong acids and some concentrated weak acids are corrosive, but there are exceptions such as carboranes and boric acid.

There are three common definitions for acids: the Arrhenius definition, the Brønsted-Lowry definition, and the Lewis definition. The Arrhenius definition states that acids are substances which increase the concentration of hydronium ions (H_3O^+) in solution. The Brønsted-Lowry definition is an expansion: an acid is a substance which can act as a proton donor. Most acids encountered in everyday life are aqueous solutions, or can be dissolved in water, and these two definitions are most relevant. The reason why pHs of acids are less than 7 is that the concentration of hydronium ions is greater than 10^{-7} moles per liter. Since pH is defined as the negative logarithm of the concentration of hydronium ions, acids thus have pHs of less than 7. By the Brønsted-Lowry definition, any compound which can easily be deprotonated can be considered an acid. Examples include alcohols and amines which contain O-H or N-H fragments.

In chemistry, the Lewis definition of acidity is frequently encountered. Lewis acids are electron-pair acceptors. Examples of Lewis acids include all metal cations, and electron-deficient molecules such as boron trifluoride and aluminium trichloride. Hydronium ions are acids according to all three definitions. Interestingly, although alcohols and amines can be Brønsted-Lowry acids as mentioned above, they can also function as Lewis bases due to the lone pairs of electrons on their oxygen and nitrogen atoms.

Arrhenius acids

The Swedish chemist Svante Arrhenius attributed the properties of acidity to hydrogen in 1884. An **Arrhenius acid** is a substance that increases the concentration of the hydronium ion, H_3O^+ , when dissolved in water. This definition stems from the equilibrium dissociation of water into hydronium and hydroxide (OH^-) ions:[2]



In pure water the majority of molecules exist as H_2O , but a small number of molecules are constantly dissociating and re-associating. Pure water is neutral with respect to acidity or basicity because the concentration of

hydroxide ions is always equal to the concentration of hydronium ions. An Arrhenius base is a molecule which increases the concentration of the hydroxide ion when dissolved in water. Note that chemists often write $H^+(aq)$ and refer to the hydrogen ion when describing acid-base reactions but the free hydrogen nucleus, a proton, does not exist alone in water, it exists as the hydronium ion, H_3O^+ .

Brønsted-Lowry acids

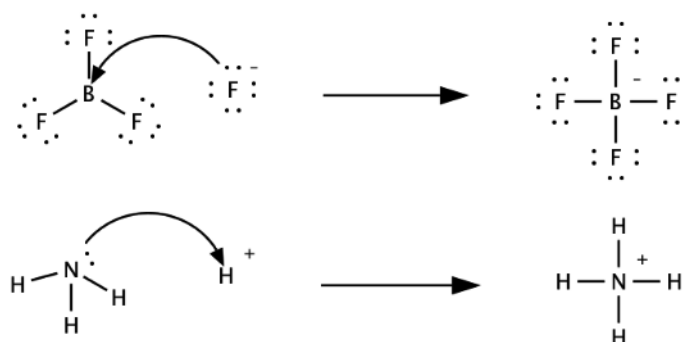
While the Arrhenius concept is useful for describing many reactions, it is also quite limited in its scope. In 1923 chemists Johannes Nicolaus Brønsted and Thomas Martin Lowry independently recognized that acid-base reactions involve the transfer of a proton. A **Brønsted-Lowry acid** (or simply Brønsted acid) is a species that donates a proton to a Brønsted-Lowry base.[2] Brønsted-Lowry acid-base theory has several advantages over Arrhenius theory. Consider the following reactions of acetic acid (CH_3COOH), the organic acid that gives vinegar its characteristic taste:

As with the acetic acid reactions, both definitions work for the first example, where water is the solvent and hydronium ion is formed. The next two reactions do not involve the formation of ions but are still proton transfer reactions. In the second reaction hydrogen chloride and ammonia (dissolved in benzene) react to form solid ammonium chloride in a benzene solvent and in the third gaseous HCl and NH_3 combine to form the solid.

Lewis acids

A third concept was proposed in 1923 by Gilbert N. Lewis which includes reactions with acid-base characteristics that do not involve a proton transfer. A **Lewis acid** is a species that accepts a pair of electrons from another species; in other words, it is an electron pair acceptor.[2] Brønsted acid-base reactions are proton transfer reactions while Lewis acid-base reactions are electron pair transfers. All Brønsted acids are also Lewis acids, but not all Lewis acids are Brønsted acids. Contrast the following reactions which could be described in terms of acid-base chemistry.

Picture 1. Lewis theory



In the first reaction a fluoride ion, F^- , gives up an electron pair to tetrafluoroborate. Fluoride "loses" a pair of valence electrons because the electrons shared in the B—F bond are located in the region of space between the two atomic nuclei and are therefore more distant from the fluoride nucleus than they are in the lone fluoride ion. BF_3 is a Lewis acid because it accepts the electron pair from fluoride. This reaction cannot be described in terms of Brønsted theory because there is no proton transfer. The second reaction can be described using either theory. A proton is transferred from an unspecified Brønsted acid to ammonia, a Brønsted base; alternatively, ammonia acts as a Lewis base and transfers a lone pair of electrons to form a bond with a hydrogen ion. The species that gains the electron pair is the Lewis acid; for example, the oxygen atom in H_3O^+ gains a pair of electrons when one of the H—O bonds is broken and the electrons shared in the bond become localized on oxygen. Depending on the context, a Lewis acid may also be described as an oxidizer or an electrophile.

The Brønsted-Lowry definition is the most widely used definition; unless otherwise specified acid-base reactions are assumed to involve the transfer of a proton (H^+) from an acid to a base.

Task 1. Text I comprehension

- 1.1. What are the most popular acids in everyday life?
- 1.2. What state can acids be?
- 1.3. Are gaseous acids possible?
- 1.4. Are all acids corrosive?
- 1.5. What are the most common definition of acids?
- 1.6. Which definition is an expansion?
- 1.7. What state acids do people encounter in everyday life?
- 1.8. How much is pH level in acids?
- 1.9. Are Lewis acids electron donors?
- 1.10. Which ions are acids according to all theories?
- 1.11. What is interesting about alcohols and amines?
- 1.12. Why is duality possible?
- 1.13. What is an Arrhenius base?
- 1.14. Does a free hydrogen nucleus exist alone in water?
- 1.15. What did the chemists Brønsted and Lowry realize?
- 1.16. What gives vinegar its characteristic taste?
- 1.17. Which is the oldest theory?
- 1.18. Write the chemical reactions of Lewis theory (Picture 1).
- 1.19. What is the singular form of nuclei?
- 1.20. What is interesting about Reaction 2(Picture 1)?

Task 2. Put the correct word pairs together

- ✓ Proton solutions
- ✓ Negative donor
- ✓ Electron examples
- ✓ Common pairs
- ✓ Aqueous logarithm

Task 3. Underline the ending of the adjectives denominating acids.

Task 4. Find the antonyms of the following words

- ✓ Strong
- ✓ Bases
- ✓ Increase
- ✓ Solve
- ✓ Greater
- ✓ Common

Text II. Acid strength

The strength of an acid refers to its ability or tendency to lose a proton. A strong acid is one that completely dissociates in water; in other words, one mole of a strong acid HA dissolves in water yielding one mole of H^+ and one mole of the conjugate base, A^- , and none of the protonated acid HA. In contrast a weak acid only partially dissociates and at equilibrium both the acid and the conjugate base are in solution. Examples of strong acids are hydrochloric acid (HCl), hydroiodic acid (HI), hydrobromic acid (HBr), perchloric acid ($HClO_4$), nitric acid (HNO_3) and sulfuric acid (H_2SO_4). In water each of these essentially ionizes 100%. The stronger an acid is, the more easily it loses a proton, H^+ . Two key factors that contribute to the ease of deprotonation are the polarity of the H—A bond and the size of atom A, which determines the strength of the H—A bond. Acid strengths are also often discussed in terms of the stability of the conjugate base.

Stronger acids have a larger K_a and a more negative pK_a than weaker acids.

Sulfonic acids, which are organic oxyacids, are a class of strong acids. A common example is toluenesulfonic acid (tosylic acid). Unlike sulfuric acid itself, sulfonic acids can be solids. In fact, polystyrene functionalized into polystyrene sulfonate is a solid strongly acidic plastic that is filterable.

Superacids are acids stronger than 100% sulfuric acid. Examples of superacids are fluoroantimonic acid, magic acid and perchloric acid. Superacids can permanently protonate water to give ionic, crystalline hydronium "salts". They can also quantitatively stabilize carbocations.

Polarity and the inductive effect

Polarity refers to the distribution of electrons in a bond, the region of space between two atomic nuclei where a pair of electrons is shared. When two atoms have roughly the same electronegativity (ability to attract electrons) the electrons are shared evenly and spend equal time on either end of the bond. When there is a significant difference in electronegativities of two bonded atoms, the electrons spend more time near the nucleus of the more electronegative element and an electrical dipole, or separation of charges, occurs, such that there is a partial negative charge localized on the electronegative element and a partial positive charge on the electropositive element. Hydrogen is an electropositive element and accumulates a slightly positive charge when it is bonded to an electronegative element such as oxygen or bromine. As the electron density on hydrogen decreases it is more easily abstracted, in other words, it is more acidic. Moving from left to right across a row on the periodic table elements become more electronegative (excluding the noble gases), and the strength of the binary acid formed by the element increases accordingly.

Task 1. Text II comprehension

- 1.1. How will you define a strong acid?
- 1.2. Does a strong acid dissolve completely in water?
- 1.3. How can you measure acid strength?
- 1.4. Which are the key factors for deprotonation?
- 1.5. Which term describes acid strength?
- 1.6. Are organic oxyacids strong acids?
- 1.7. Can tosylic acid be solid?
- 1.8. what are superacids
- 1.9. What is a bond?
- 1.10. What happens if the atoms have the same electronegativity?
- 1.11. When does a separation of charges occur?
- 1.12. Is hydrogen an electronegative element?
- 1.13. Which elements have got a negative charge?
- 1.14. Does acidity increase with electron density?

Task 2. Find the examples of adjectives in a basic degree.

Task 3. Find the examples of the comparative degree of the adjectives.

Task 4. Find the words that describe the strength of the acid.

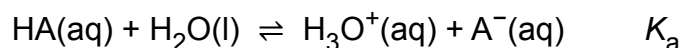
Task 5. Explain the meanings of the homonyms

- ✓ Partial
- ✓ Noble
- ✓ Charge

Text III. Chemical properties

Monoprotic acids

Monoprotic acids are those acids that are able to donate one proton per molecule during the process of dissociation (sometimes called ionization) as shown below (symbolized by HA):

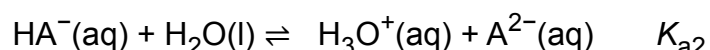
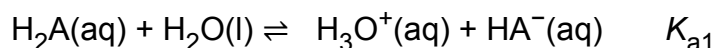


Common examples of monoprotic acids in mineral acids include hydrochloric acid (HCl) and nitric acid (HNO₃). On the other hand, for organic acids the term mainly indicates the presence of one carboxylic acid group and sometimes these acids are known as monocarboxylic acid. Examples in organic acids include formic acid (HCOOH), acetic acid (CH₃COOH) and benzoic acid (C₆H₅COOH).

Polyprotic acids

Polyprotic acids, also known as polybasic acids, are able to donate more than one proton per acid molecule, in contrast to monoprotic acids that only donate one proton per molecule. Specific types of polyprotic acids have more specific names, such as diprotic acid (two potential protons to donate) and triprotic acid (three potential protons to donate).

A diprotic acid (here symbolized by H₂A) can undergo one or two dissociations depending on the pH. Each dissociation has its own dissociation constant, K_{a1} and K_{a2}.



The first dissociation constant is typically greater than the second; i.e., K_{a1} > K_{a2}. The large K_{a1} for the first dissociation makes sulfuric a strong acid. In a similar manner, the weak unstable carbonic acid (H₂CO₃) can lose one proton to form bicarbonate anion (HCO₃⁻) and lose a second to form carbonate anion (CO₃²⁻). Both K_a values are small, but K_{a1} > K_{a2}.

An inorganic example of a triprotic acid is orthophosphoric acid (H₃PO₄), usually just called phosphoric acid. An organic example of a triprotic acid is citric acid, which can successively lose three protons to finally form the citrate ion. Even though the positions of the protons on the original molecule may be equivalent, the successive K_a values will differ since it is energetically less favorable to lose a proton if the conjugate base is more negatively charged.

Although the subsequent loss of each hydrogen ion is less favorable, all of the conjugate bases are present in solution. The fractional concentration, α (alpha), for each species can be calculated. For example, a generic diprotic

acid will generate 3 species in solution: H_2A , HA^- , and A^{2-} . The fractional concentrations can be calculated as below when given either the pH (which can be converted to the $[H^+]$) or the concentrations of the acid with all its conjugate bases .

Properties of Acids

- ✓ taste sour (don't taste them!)... the word 'acid' comes from the Latin *acere*, which means 'sour'
- ✓ acids change litmus (a blue vegetable dye) from blue to red
- ✓ their aqueous (water) solutions conduct electric current (are electrolytes)
- ✓ react with bases to form salts and water
evolve hydrogen gas (H_2) upon reaction with an active metal (such as alkali metals, alkaline earth metals, zinc, aluminium).

Task 1. Text III comprehension

- 1.1. What is a monoprotic acid?
- 1.2. What is the other name of dissociation?
- 1.3. What are the most popular monoprotic acids?
- 1.4. What are polyprotic acids?
- 1.5. What can a triprotic acid do?
- 1.6. Which is the most popular inorganic triprotic acid?
- 1.7. Which is the most popular organic triprotic acid?
- 1.8. Is it possible to calculate fractional concentrations of triprotic acids?
- 1.9. How do acids taste?
- 1.10. Which is the language of origin of the word acid?
- 1.11. What property do acid water solutions possess?
- 1.12. What substances can acids react with?
- 1.13. What are the colours of indicator papers when they are emerged into acid solutions?

Task 2. Explain the meaning of the prefixes

- ✓ mono
- ✓ poly
- ✓ di

Task 3. Find the examples of strong and weak acids.

Task 4. Find the linking words and explain their role in the sentence.

Task 5. Find the suffixes which describes acids.

Text IV Applications of acids

There are numerous uses for acids. Acids are often used to remove rust and other corrosion from metals in a process known as pickling. They may be used as an electrolyte in a wet cell battery, such as sulfuric acid in a car battery.

Strong acids, sulfuric acid in particular, are widely used in mineral processing. For example, phosphate minerals react with sulfuric acid to produce phosphoric acid for the production of phosphate fertilizers, and zinc is produced by dissolving zinc oxide into sulfuric acid, purifying the solution and electrowinning.

In the chemical industry, acids react in neutralization reactions to produce salts. For example, nitric acid reacts with ammonia to produce ammonium nitrate, a fertilizer. Additionally, carboxylic acids can be esterified with alcohols, to produce esters.

Acids are used as additives to drinks and foods, as they alter their taste and serve as preservatives. Phosphoric acid, for example, is a component of cola drinks. Acetic acid is used in day to day life as vinegar. Carbonic acid is an important part of some cola drinks and soda. Citric acid is used as a preservative in sauces and pickles.

Tartaric acid is an important component of some commonly used foods like unripened mangoes and tamarind. Natural fruits and vegetables also contain acids. Citric acid is present in oranges, lemon and other citrus fruits. Oxalic acid is present in tomatoes, spinach, and especially in carambola and rhubarb; rhubarb leaves and unripe carambolas are toxic because of high concentrations of oxalic acid.

Ascorbic acid (Vitamin C) is an essential vitamin required in our body and is present in such foods as amla, lemon, citrus fruits, and guava.

Certain acids are used as drugs. Acetylsalicylic acid (Aspirin) is used as a pain killer and for bringing down fevers.

Acids play very important roles in the human body. The hydrochloric acid present in our stomach aids in digestion by breaking down large and complex food molecules. Amino acids are required for synthesis of proteins required for growth and repair of our body tissues. Fatty acids are also required for growth and repair of body tissues. Nucleic acids are important for the manufacturing of DNA, RNA and transmission of characters to offspring through genes. Carbonic acid is important for maintenance of pH equilibrium in it.

1. What acid is used in a car battery?
2. Why are acids used in drinks?
3. What is their application in the chemical industry?
4. What acid does a solution of vinegar contain?
5. Does cola contain any acids?
6. What is vitamin C?
7. What acid is present in tomatoes?
8. What is aspirin?
9. What does hydrochloric acid do in human stomachs?
10. What function do amino acids fulfil?
11. Why are fatty acids needed?
12. What do nucleic acids do?
13. What acid is responsible for maintenance of pH equilibrium?

Task 2. Explain the difference of meaning

- ✓ pickles and pickling
- ✓ preservatives and additives
- ✓ unripened and unripe

Task 3. Find the meaning changing the part of speech

- ✓ present
- ✓ aids
- ✓ produce
- ✓ stomach
- ✓ process

Task 4. Comment upon word pairs

- ✓ important and essential
- ✓ alter and serve
- ✓ growth and repair

Chapter V. Electrolysis

Text I. History

The word electrolysis comes from the Greek ἤλεκτρον [ēlektron] "amber" and λύσις [lýsis] "dissolution".

- ✓ 1800 – William Nicholson and Johann Ritter decomposed water into hydrogen and oxygen.
- ✓ 1807 – Potassium, sodium, barium, calcium and magnesium were discovered by Sir Humphry Davy using electrolysis.
- ✓ 1875 – Paul Emile Lecoq de Boisbaudran discovered gallium using electrolysis.[1]
- ✓ 1886 – Fluorine was discovered by Henri Moissan using electrolysis.
- ✓ 1886 – Hall-Héroult process developed for making aluminium
- ✓ 1890 – Castner-Kellner process developed for making sodium hydroxide

Electrolysis is the passage of a direct electric current through an ionic substance that is either molten or dissolved in a suitable solvent, resulting in chemical reactions at the electrodes and separation of materials.

The main components required to achieve electrolysis are:

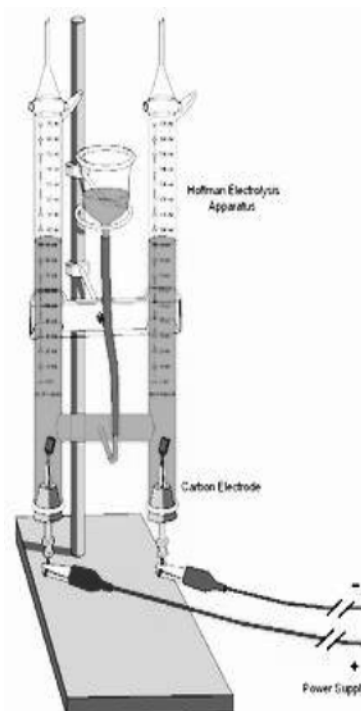
- ✓ An electrolyte: a substance containing free ions which are the carriers of electric current in the electrolyte. If the ions are not mobile, as in a solid salt then electrolysis cannot occur.
- ✓ A direct current (DC) supply: provides the energy necessary to create or discharge the ions in the electrolyte. Electric current is carried by electrons in the external circuit.
- ✓ Two electrodes : an electrical conductor which provides the physical interface between the electrical circuit providing the energy and the electrolyte.

Electrodes of metal, graphite and semiconductor material are widely used. Choice of suitable electrode depends on chemical reactivity between the electrode and electrolyte and the cost of manufacture.

In chemistry and manufacturing, **electrolysis** is a method of using a direct electric current (DC) to drive an otherwise non-spontaneous chemical reaction. Electrolysis is commercially highly important as a stage in the separation of elements from naturally occurring sources such as ores using an electrolytic cell.

Task 1.Text I comprehension.

- 1.What language does the word electrolysis come from?
2. Which century is famous for discoveries in electrolysis?



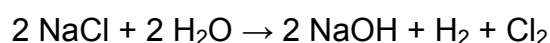
3. What current is used in the process of electrolysis?
4. What is the definition of electrolysis?
5. What is an electrolyte?
6. What is the possible material of electrodes?
7. What do ores consist of?
8. What is meant by physical interface?
9. What does an electrical conductor do?
10. What is the requirement for ions in an electrolyte?

Task 2. Describe an apparatus of electrolysis.

Task 3. Place the names of the researchers in alphabetical order.

Text II. Process of electrolysis

The key process of electrolysis is the interchange of atoms and ions by the removal or addition of electrons from the external circuit. The required products of electrolysis are in some different physical state from the electrolyte and can be removed by some physical processes. For example, in the electrolysis of brine to produce hydrogen and chlorine, the products are gaseous. These gaseous products bubble from the electrolyte and are collected.[2]



A liquid containing mobile ions (electrolyte) is produced by

- ✓ Solvation or reaction of an ionic compound with a solvent (such as water) to produce mobile ions
- ✓ An ionic compound is melted (*fused*) by heating

An electrical potential is applied across a pair of electrodes immersed in the electrolyte.

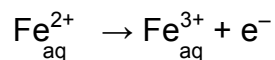
Each electrode attracts ions that are of the opposite charge. Positively charged ions (cations) move towards the electron-providing (negative) cathode, whereas negatively charged ions (anions) move towards the positive anode.

At the electrodes, electrons are absorbed or released by the atoms and ions. Those atoms that gain or lose electrons to become charged ions pass into the electrolyte. Those ions that gain or lose electrons to become uncharged atoms separate from the electrolyte. The formation of uncharged atoms from ions is called discharging.

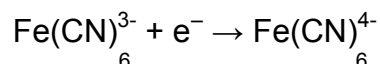
The energy required to cause the ions to migrate to the electrodes, and the energy to cause the change in ionic state, is provided by the external source of electrical potential.

Oxidation and reduction at the electrodes

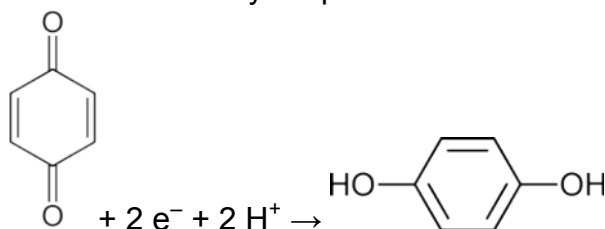
Oxidation of ions or neutral molecules occurs at the anode, and the reduction of ions or neutral molecules occurs at the cathode. For example, it is possible to oxidize ferrous ions to ferric ions at the anode:



It is also possible to reduce ferricyanide ions to ferrocyanide ions at the cathode:



Neutral molecules can also react at either electrode. For example: p-Benzoquinone can be reduced to hydroquinone at the cathode:



In the last example, H^+ ions (hydrogen ions) also take part in the reaction, and are provided by an acid in the solution, or the solvent itself (water, methanol etc.). Electrolysis reactions involving H^+ ions are fairly common in acidic solutions. In alkaline water solutions, reactions involving OH^- (hydroxide ions) are common.

The substances oxidised or reduced can also be the solvent (usually water) or the electrodes. It is possible to have electrolysis involving gases.

Energy changes during electrolysis

The amount of electrical energy that must be added equals the change in Gibbs free energy of the reaction plus the losses in the system. The losses can (in theory) be arbitrarily close to zero, so the maximum thermodynamic efficiency equals the enthalpy change divided by the free energy change of the reaction. In most cases, the electric input is larger than the enthalpy change of the reaction, so some energy is released in the form of heat. In some cases, for instance, in the electrolysis of steam into hydrogen and oxygen at high temperature, the opposite is true. Heat is absorbed from the surroundings, and the heating value of the produced hydrogen is higher than the electric input.

Related techniques

The following techniques are related to electrolysis:

- ✓ Electrochemical cells, including the hydrogen fuel cell, utilise differences in Standard electrode potential in order to generate an electrical potential from which useful power can be extracted. Although related via the interaction of ions and electrodes, electrolysis and the operation of electrochemical cells are quite distinct. A chemical cell should *not* be thought of as performing "electrolysis in reverse".

Task 1. Text II comprehension.

- ✓ How is a liquid containing mobile ions produced?
- ✓ What is solvation?
- ✓ How is the energy causing ions to migrate provided?
- ✓ What is the adjective from the noun gas?
- ✓ Where does the reduction of ions take place?
- ✓ Find the examples of oxidizing.
- ✓ What ions take part in electrolysis of alkaline water solutions?
- ✓ Can heating value exceed the electric input?
- ✓ Are there any differences between electrolysis and electrochemical cells?
- △ Define enthalpy.

Task 2. Find the examples of linking verbs in the text.**Task 3. Find the examples of Passive Voice.****Task 4. Find the antonyms of the words**

- △ Charge
- △ External
- △ Cation
- △ Absorb

Text III. Faraday's laws of electrolysis***First law of electrolysis***

In 1832, Michael Faraday reported that the quantity of elements separated by passing an electric current through a molten or dissolved salt is proportional to the quantity of electric charge passed through the circuit. This became the basis of the first law of electrolysis:

$$m = k \cdot q$$

Second law of electrolysis

Faraday also discovered that the mass of the resulting separated elements is directly proportional to the atomic masses of the elements when an appropriate integral divisor is applied. This provided strong evidence that discrete particles of matter exist as parts of the atoms of elements.

Industrial uses

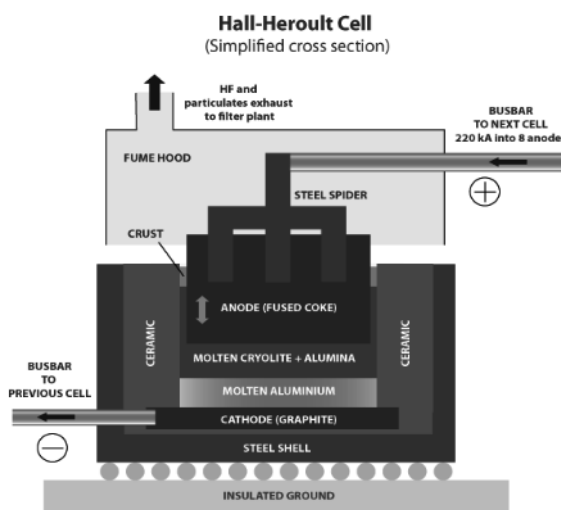
Hall-Heroult process for producing aluminium

- ✓ Production of aluminium, lithium, sodium, potassium, magnesium, calcium
- ✓ Coulometric techniques can be used to determine the amount of matter transformed during electrolysis by measuring the amount of electricity required to perform the electrolysis
- ✓ Production of chlorine and sodium hydroxide
- ✓ Production of sodium chlorate and potassium chlorate

- ✓ Production of perfluorinated organic compounds such as trifluoroacetic acid
- ✓ Production of electrolytic copper as a cathode, from refined copper of lower purity as an anode.

Electrolysis has many other uses:

- ✓ Electrometallurgy is the process of reduction of metals from metallic compounds to obtain the pure form of metal using electrolysis. For example, sodium hydroxide in its molten form is separated by electrolysis into sodium and oxygen, both of which have important chemical uses. (Water is produced at the same time.)
- ✓ Anodization is an electrolytic process that makes the surface of metals resistant to corrosion. For example, ships are saved from being corroded by oxygen in the water by this process. The process is also used to decorate surfaces.
- ✓ A battery works by the reverse process to electrolysis.
- ✓ Production of oxygen for spacecraft and nuclear submarines.
- ✓ Electroplating is used in layering metals to fortify them. Electroplating is used in many industries for functional or decorative purposes, as in vehicle bodies and nickel coins.
- ✓ Production of hydrogen for fuel, using a cheap source of electrical energy.
- ✓ Electrolytic Etching of metal surfaces like tools or knives with a permanent mark or logo.



Electrolysis is also used in the cleaning and preservation of old artifacts. Because the process separates the non-metallic particles from the metallic ones, it is very useful for cleaning old coins and even larger objects.

Task 1. Text III comprehension.

1. What salt is meant in the first law of electrolysis?
2. What is anodization?
3. What is the meaning of discrete particles?
4. What metals are produced by electrolysis?
5. What gas is produced by electrolysis?
6. What does electrometallurgy produce?
7. How does a battery work?
8. What is the use of electroplating?
9. Why is electrolysis used for cleaning old coins?
10. Which metal is produced in the Hall-Heroult cell?

Task 2. Describe the terms of the first law of electrolysis.

Task 3. List the industrial uses of electrolysis.

Task 4. Explain the meaning of the word artifacts.

Text IV. Competing half-reactions in solution electrolysis

Using a cell containing inert platinum electrodes, electrolysis of aqueous solutions of some salts leads to reduction of the cations (e.g., metal deposition with, e.g., zinc salts) and oxidation of the anions (e.g. evolution of bromine with bromides). However, with salts of some metals (e.g. sodium) hydrogen is evolved at the cathode, and for salts containing some anions (e.g. sulfate SO_4^{2-}) oxygen is evolved at the anode. In both cases this is due to water being reduced to form hydrogen or oxidised to form oxygen. In principle the voltage required to electrolyse a salt solution can be derived from the standard electrode potential for the reactions at the anode and cathode. The standard electrode potential is directly related to the Gibb's free energy, ΔG , for the reactions at each electrode and refers to an electrode with no current flowing. An extract from the table of standard electrode potentials is shown below.

Half-reaction	E° (V)	
$\text{Na}^+ + e^- \rightleftharpoons \text{Na}(s)$	-2.71	
$\text{Zn}^{2+} + 2e^- \rightleftharpoons \text{Zn}(s)$	-0.7618	
$2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2(g)$	$\equiv 0$	
$\text{Br}_2(aq) + 2e^- \rightleftharpoons 2\text{Br}^-$	+1.0873	[4]
$\text{O}_2(g) + 4\text{H}^+ + 4e^- \rightleftharpoons 2\text{H}_2\text{O}$	+1.23	[3]
$\text{Cl}_2(g) + 2e^- \rightleftharpoons 2\text{Cl}^-$	+1.36	[3]
$\text{S}_2\text{O}_8^{2-} + 2e^- \rightleftharpoons 2\text{SO}_4^{2-}$	+2.07	[3]

In terms of electrolysis, this table should be interpreted as follows

- ✓ oxidised species (often a cation) nearer the top of the table are more difficult to reduce than oxidised species further down. For example it is more difficult to reduce sodium ion to sodium metal than it is to reduce zinc ion to zinc metal.
- ✓ reduced species (often an anion) near the bottom of the table are more difficult to oxidise than reduced species higher up. For example it is more difficult to oxidise sulfate anions than it is to oxidise bromide anions.

Using the Nernst equation the electrode potential can be calculated for a specific concentration of ions, temperature and the number of electrons involved. For pure water (pH 7):

1. the electrode potential for the reduction producing hydrogen is -0.41 V
2. the electrode potential for the oxidation producing oxygen is $+0.82\text{ V}$.

Comparable figures calculated in a similar way, for 1M zinc bromide, ZnBr_2 , are -0.76 V for the reduction to Zn metal and $+1.10\text{ V}$ for the oxidation producing bromine. The conclusion from these figures is that hydrogen should be produced at the cathode and oxygen at the anode from the electrolysis of water which is at variance with the experimental observation that zinc metal is deposited and bromine is produced. The explanation is that these calculated potentials only indicate the thermodynamically preferred reaction. In practice many other factors have to be taken into account such as the kinetics of some of the reaction steps involved. These factors together mean that a higher potential is required for the reduction and oxidation of water than predicted, and these are termed overpotentials. Experimentally it is known that overpotentials depend on the design of the cell and the nature of the electrodes.

For the electrolysis of a neutral (pH 7) sodium chloride solution, the reduction of sodium ion is thermodynamically very difficult and water is reduced evolving hydrogen leaving hydroxide ions in solution. At the anode the oxidation of chlorine is observed rather than the oxidation of water since the overpotential for the oxidation of chloride to chlorine is lower than the overpotential for the oxidation of water to oxygen. The hydroxide ions and dissolved chlorine gas react further to form hypochlorous acid. The aqueous solutions resulting from this process is called electrolyzed water and is used as a disinfectant and cleaning agent.

Task 1. Text IV comprehension.

- ✓ What does evolution mean in case of electrolysis?
- ✓ Why is oxygen evolved at the anode in some cases?
- ✓ How can the needed voltage be measured?
- ✓ Is the standard electrode potential related to Gibb's free energy?
- ✓ Why are these reactions called half-reactions?
- ✓ Which oxidised species are more difficult to reduce?
- ✓ Which reduced species are more difficult to oxidise?
- ✓ How can the electrode potential be calculated?
- ✓ What reaction do these potentials show?
- ✓ What is an overpotential?

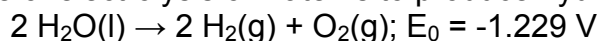
Task 2. Describe the table.

Task 3. Determine the parts of speech for

- ✓ Oxidise
- ✓ Reduce.

Text V. Electrolysis of water

One important use of electrolysis of water is to produce hydrogen.



Hydrogen can be used as a fuel for powering internal combustion engines by combustion or electric motors via hydrogen fuel cells. This has been suggested as one approach to shift economies of the world from the current state of almost complete dependence upon hydrocarbons for energy. The energy efficiency of water electrolysis varies widely. The efficiency is a measure of what fraction of electrical energy used is actually contained within the hydrogen. Some of the electrical energy is converted to heat, an almost useless byproduct. Some reports quote efficiencies between 50% and 70%. This efficiency is based on the Lower Heating Value of Hydrogen. The Lower Heating Value of Hydrogen is total thermal energy released when hydrogen is combusted minus the latent heat of vaporisation of the water. This does not represent the total amount of energy within the hydrogen, hence the efficiency is lower than a more strict definition. Other reports quote the theoretical maximum efficiency of electrolysis as being between 80% and 94%. The theoretical maximum considers the total amount of energy absorbed by both the hydrogen and oxygen. These values refer only to the efficiency of converting electrical energy into hydrogen's chemical energy. The energy lost in generating the electricity is not included. For instance, when considering a power plant that converts the heat of nuclear reactions into hydrogen via electrolysis, the total efficiency is more likely to be between 25% and 40%. National Renewable Energy Laboratory(USA) found that a kilogram of hydrogen (roughly equivalent to a gallon of gasoline) could be produced by wind powered electrolysis for between \$5.55 in the near term and \$2.27 in the long term.

About four percent of hydrogen gas produced worldwide is created by electrolysis, and normally used onsite. Hydrogen is used for the creation of ammonia for fertilizer via the Haber process, and converting heavy petroleum sources to lighter fractions via hydrocracking.

Task 1. Text V comprehension.

- ✓ What are the ways of using hydrogen?
- ✓ What source of energy is used nowadays?
- ✓ Is the energy efficiency of water constant?
- ✓ How much energy is converted to heat?
- ✓ What does the word latent mean?
- ✓ What is the total thermal energy?
- ✓ What energy does the efficiency refer to?
- ✓ Is the lost energy included?
- ✓ What is a power plant?
- ✓ Is hydrogen transportable?

Task 2. Write the equation of the lower heating value of hydrogen.

Task 3. Define the efficiency.

List of literature

1. <http://virual.yosemite.cc.ca.us>
2. <http://misterguch.brinkster.net>
3. <http://www.sciencegeek.net>
4. <http://en.wikipedia.org/wiki/Titration>
5. <http://chemistry.about.com>
6. [http://dictionary. Reference.com](http://dictionary.Reference.com)

Pictures are taken from

- titration.gif
- titration-equipment1.jpg
- wikimedia commons