Regulations
of the International Chemistry Olympiad (IChO)

General Statement

§ 1

Aims of the competition

The International Chemistry Olympiad (IChO) is a chemistry competition for students at secondary school level with the aim of promoting international contacts in chemistry. It is intended to stimulate the activities of students interested in chemistry by way of the independent and creative solution of chemical problems. The IChO competitions help to facilitate cordial relations between young adults of different nationalities; they encourage cooperation and international understanding.

Organization of IChO

§ 2

Organization and invitation

(1) The IChO is organized every year, as a rule at the beginning of July, in one of the participating countries by the Education Ministry or an appropriate institution of the organizing country (hereafter referred to as the organizer).

(2) Unless directed otherwise by the International Jury, the organizer is obliged to invite all countries that participated with a team during either of the preceding two IChO competitions. The official invitation to participate in the forthcoming IChO should be sent to countries by the November preceding the competition. The countries invited must confirm their participation in the IChO according to requirements of the organizer.

(3) Countries not automatically invited to the IChO must apply to the organizer by the end of November preceding the Olympiad. The organizer invites these countries to the Olympiad based on the recommendation of the Steering Committee. Participating countries are expected to select representative teams in an open process.
Newly invited countries must send an observer to two consecutive Olympiads before its pupils can participate in the IChO. The observer participates in Jury meetings and all Olympiad procedures as a non-voting member in order to learn about the content and procedure of the competition.

§ 3 Delegations

(1) Each participating country's delegation consists of competitors and accompanying persons (also known as mentors). It is expected that there are four competitors and two mentors in the delegation. Furthermore, the countries may include two scientific observers as part of their delegation.
(2) The competitors must not be university students. They can only be students of secondary schools that are not specialized in chemistry and, if they have already graduated before the 1st of May of the year of the competition, the organizer must be informed as to the

month and year of their graduation. Moreover, they must be under the 20 years of age on the 1st of July of the year of the competition. The competitors must be passport holders of the country they represent or have taken part in the secondary school educational system of this country for more 2 than one academic year. All members of a delegation must provide themselves with medical insurance for the journey to and from the organizing country and for the period of their stay in the organizing country.

(3) The mentors:

a) act as members of the International Jury (see § 6). One of the mentors is designated as the head of delegation (head mentor).

b) must guarantee the fulfillment of those conditions specified in section 2 of this paragraph,

c) must be capable of translating the text of the competition tasks from English into the language used by their students and be able to judge the set of tasks and correct the work of the students.

d) have the right to enter a protest which should be addressed to the Chair of the Steering Committee and, when necessary, ask for a resolution of the problem at the next meeting of the International Jury.

§ 4
Obligations of the Organizer

(1) The organizer provides:

a) the itinerary of the IChO,

b) transportation from/to an airport/station (which is designated by the host country) on the day of arrival and departure,

c) that the organization of the competition will adhere to the regulations,

d) accident insurance for all participants in connection with the itinerary,

e) the opportunity for the mentors to inspect the working room and practical apparatus to be used for the practical tasks before the competition takes place,

f) all necessary arrangements for the observance of safety regulations,

g) the medals, certificates and prizes, which are presented at the official closing ceremony,

h) a report on the competition to be distributed not later than six months after the competition.

(2) A meeting of the Steering Committee must be hosted in the organizing country at least 5 months prior to the IChO. The organizing country will provide some travel assistance.

§ 5
Financing

(1) The participating country covers the return travel costs of the students and the accompanying persons to the designated airport/station or to the location where the competition is held.

(2) Participating countries must pay a participation fee, the amount of which must be approved by the International Jury.

(3) Scientific observers pay a participation fee. The amount is determined by the organizer and must be announced at least one year ahead.

(4) All members of a delegation must provide themselves with medical insurance for the journey to and from the organizing country and for the period of their stay in the organizing country.

(5) All other costs incurred in connection with the organized program, including the costs of accommodation for all competitors and members of the International Jury, are covered by the organizer.

(6) The organizers of the next two consecutive Olympiads may send two observers to the current IChO with their expenses covered by the host as mentioned in § 5, section 5.

Institutions of the IChO

§ 6
International Jury

(1) The International Jury of the IChO consists of the head mentors from the countries participating in the olympiads. The term of the Jury starts at the opening ceremony of the olympiad and finishes at the opening of the following olympiad.

(2) The chair of the Steering Committee or his/her delegate calls and chairs the meetings of the International Jury.

(3) The working language of the International Jury is English.

(4) Each participating country has one vote. Resolutions are passed with a simple majority of the votes cast. Changes in the regulations require a qualified majority of two thirds of all Jury members. The decisions of the International Jury are binding for both organizer and participants.

(5) The discussion of the tasks may take place in two simultaneous meetings (split sessions) where the head mentors delegate a representative to discuss and vote on a subset of tasks.

§ 7
Responsibilities of the International Jury

(1) The International Jury:
a) is in charge of the actual competition and its supervision according to the regulations,
b) approves future organizers for the IChO,
c) discusses in advance the competition tasks presented by the organizer, their solutions and the marking guidelines, gives comments and takes decisions in case of changes,
d) supervises the marking of the examination papers and guarantees that all participants are judged by equal criteria,
e) monitors the competition and suggests changes to the regulations, organization and contents for future IChOs,
f) makes decisions on the exclusion of a participant or an entire team from the competition (see also § 11, section 7),
g) elects members of the Steering Committee of the IChO,
h) may form working groups to solve specific chemistry related problems of the IChO.

(2) The members of the International Jury:

a) are obliged to maintain a professional discretion about any relevant information they receive during the IChO and must not assist any participants,
b) keep the marking and results secret until announced by the International Jury. 4

§ 8
Steering Committee

(1) The long term work involved in organizing the International Chemistry Olympiads is coordinated by the Steering Committee.

(2) Members of the Committee are elected by the International Jury by a secret ballot to serve a two year term. There must be at least one person from each of the following regions: the Americas, Asia and Europe. Other three members can come from any region. The term of the elected committee begins on the 1st day after the IChO. Members are elected for no more than two consecutive terms.

(3) There are the following ex-officio members of the Steering Committee:
a) a representative of the current IChO,
b) a representative of the immediately preceding IChO,
c) representatives of the subsequent IChOs approved by the International Jury,
d) the immediate past chair of the SC (for one year only)

(4) The incoming Steering Committee elects its own Chair from among its elected members at a meeting held before the committee's term begins.
The Chair:
a) calls and chairs the meetings of the Steering Committee,
b) calls and chairs the meetings of the International,
c) may invite non-voting guests to the meetings of the Steering Committee after consultation with the host of the meeting,
d) has the right to call extraordinary meetings of the International Jury when necessary.

(5) The Steering Committee:
a) provides organizational oversight for the International Chemistry Olympiad and gives recommendations to the organizers,
b) proposes items for consideration at the International Jury sessions.
c) may co-opt 1–3 non-voting members for their particular expertise for periods of one year.
d) may invite representatives of confirmed future IChOs.

(6) The Steering Committee is not empowered to make any decisions affecting the International Chemistry Olympiad that would interfere with the duties and responsibilities of the International Jury (see § 6 and 7).

§ 9
International Information Center

There is an International Information Center of the International Chemistry Olympiads gathering and providing (when necessary) all the documentation of the IChOs from the beginning of the Olympiad to the present. The seat of the Office is in Bratislava, Slovakia.

§ 10
Preparation for the IChO competition

(1) The organizer distributes a set of preparatory tasks written in English to all participating countries in January of the competition year. The preparatory tasks are intended to give students a good idea of the type and difficulty of the competition tasks, including safety aspects (see §12 and Appendix A and B). SI units should be used throughout the preparatory tasks. 5

(2) The total number of theoretical and experimental tasks in the set of preparatory problems cannot be lower than 25 and 5, respectively.

(3) Appendix C of the regulations contains a list of concepts and skills expected to be mastered by the participants. Organizers may freely include questions and tasks in the theoretical or experimental competition based on the knowledge listed there. The organizer can include problems in the exams based on the use of concepts and skills from not more than 6 theoretical and 2 practical fields outside this list, if a minimum of 2 tasks from each field is included and the necessary skills demonstrated in the set of preparatory problems. Examples of such external fields are listed in Appendix C. Fields not already listed should have a breadth similar to the examples. These 6 theoretical and 2 practical fields must be stated explicitly at the beginning of the Preparatory problems. If an equation not covered by the listed fields is required for the solution of the exam questions, then this should be defined in the exam text.

(4) Appendix D contains an outline of the factual knowledge supposedly familiar to the competitors. If specific facts, not included in Appendix D, are required for the solution of the exam questions, then these should be included in the exam text or in the preparatory problems and their solutions.

(5) Training or any other special instruction, that is carried out for a selected group of 50 or fewer students, containing the IChO team, must be no longer than two weeks.

§ 11
Organization of the IChO Competition

(1) The competition consists of two parts:
a) part one, the practical (experimental) competition,
b) part two, the theoretical competition.

(2) A working time of four to five hours is allotted for each part. There is at least one day of rest between the two parts.

(3) Competitors receive all relevant information in the language of their choice.

(4) There must be no contact between mentors and competitors once the mentors have received the competition tasks for consideration. Information regarding the competition tasks must not be passed to the competitors directly or indirectly prior or during the competition.

(5) When pocket calculators are not provided by the organizer, only non-programmable pocket calculators may be used in the competition.

(6) The safety regulations announced by the organizer are binding for all participants.

(7) Breaking of any of the rules given in the preceding paragraphs (§ 3. section 2, § 10 section 5, § 11 sections 4, 5, and 6) has as its consequence exclusion from the whole or a part of the competition.

§ 12
Safety

(1) During the experimental part, the competitors must wear laboratory coats and eye protection. The competitors are expected to bring their own laboratory coats. Other means of protection for laboratory work are provided by the organizer. 6

(2) When handling liquids, each student must be provided with a pipette ball or filler. Pipetting by mouth is strictly forbidden.

(3) The use of acutely toxic substances (GHS hazard statement H300, H310, H330) is strictly forbidden. The use of toxic substances is not recommended, but may be allowed if special precautions are taken. Substances with GHS hazard statements H340, H350, H360 (proven mutagens, carcinogens, and teratogens) must not be used under any circumstances (see Appendix B for definitions of these categories).

(4) Detailed recommendations involving students´ safety and the handling and disposal of chemicals can be found in Appendices A 1, A 2, and B.

a) Appendix A 1: Safety Rules for Students in the laboratory.
b) Appendix A 2: Safety Rules and Recommendations for the Host Country of the IChO.
c) Appendix B contains a reference to the hazard symbols and statements of the Globally Harmonized System of Classification of Chemicals (GHS), the use of which is expected in labeling and classifying materials used at the IChO.

§ 13
Competition Tasks

(1) The organizer is responsible for the preparation of competition tasks by competent experts/authors, who constitute the Scientific Board of the IChO. They propose the methods of solution and the marking scheme.

(2) The tasks, their solutions and the marking schemes are submitted to the International Jury for consideration and approval. The authors of the tasks should be present during the discussion.

(3) The Chair of the International Jury may put the Chair of the Scientific Board in charge of the proceedings when the tasks are considered.

(4) The total length of the theoretical or experimental tasks, including answer sheets, should be kept to a minimum and not exceed 25,000 characters. The number of characters must be stated at the end of each exam paper. SI units should be used throughout the competition tasks.

(5) In the experimental part of the competition the following conditions must be fulfilled:
a) The experimental part must contain at least two independent tasks.
b) The marking cannot require subjective interpretation by the staff.

c) Competitors must receive the same substances when solving the tasks from qualitative analytical chemistry.
d) When solving tasks from quantitative analytical chemistry competitors must receive the same substances but with different concentrations.
e) In evaluating the quantitative tasks the master values must not be based on an average of the results of the competitors.
f) The great majority of the grade in quantitative tasks must be given to the mean value as reported by the competitors while some marks may also be given to the corresponding equations, calculations, or explanations directly related to the work. Points must not be awarded for reproducibility.

§ 14
Correcting and Marking

(1) A maximum of 60 points is allocated to the theoretical tasks and 40 points to the practical tasks, making a total of 100 points.

(2) The competition tasks are corrected independently by the authors and by the mentors. Consequential marking should be used so that students are not punished twice for the same error. Both corrections are then compared; however, the authors present their evaluation first. After a discussion the final score for each participant is reached and agreed by both sides. The organizer retains the original marked manuscripts.

(3) The International Jury discusses the results and decides on the final scores.

(4) In order to eliminate any doubts about possible mistakes in the processing of the results the organizer must provide the mentors with a list of their students' total results before the closing award ceremony.

§ 15
Results and Prizes

(1) The best 10% to 12% of all competitors receive gold, the next 20% to 22% silver, and the following 30% to 32% bronze medals.

(2) An honorable mention is received by non-medalists who are in the best 70 to 71% of all competitors.

(3) The exact number of recipients for each award is determined automatically to yield the largest possible difference in the marks of students receiving different honors. In the case of identical differences, the one resulting in more medals will be selected.

(4) Each medalist must receive the medal and a corresponding certificate from the organizer.

(5) In addition to the medals other prizes may be awarded.

(6) Each competitor receives a certificate of participation.

(7) In the awarding ceremony, the non-medalists are called alphabetically.

(8) Team classification is not made.

(9) The organizer must provide a complete list of results as a part of the final report.

§ 16
Final Regulations

(1) Those who take part in the competition acknowledge these regulations through their participation.

(2) This version of regulations has been approved by the International Jury in Prague (Czech Republic) in July 2018, and is issued to replace the former regulations approved in Bangkok (Thailand) in July 2017.

(3) The regulations are valid from the 1st of September, 2018. Changes to the regulations can be made only by the International Jury and require a qualified majority (two third of the votes with regard to total number of participating countries). 8

APPENDIX A

A 1: SAFETY RULES FOR STUDENTS IN THE LABORATORY

All students of chemistry must recognize that hazardous materials cannot be completely avoided. Chemists must learn to handle all materials in an appropriate fashion. While it is not expected that all students participating in the International Chemistry Olympiad know the hazards of every chemical, the organizers of the competition will assume that all participating students know the basic safety procedures. For example, the organizers will assume that students know that eating, drinking or smoking in the laboratory or tasting a chemical is strictly forbidden.

In addition to the common-sense safety considerations to which students should have been previously exposed, some specific rules, listed below, must also be followed during the Olympiad. If any question arises concerning safety procedures during the practical exam, the student should not hesitate to ask the nearest supervisor for direction.

Rules regarding personal protection

1. Eye protection must be worn in the laboratories at all times. If the student wears contact lenses, full protection goggles must also be worn. Eye protection will be provided by the host country.
2. A laboratory coat is required. Each student will supply this item for himself/herself.
3. Long pants and closed-toed shoes are recommended for individual safety. Long hair and loose clothing should be confined.
4. Pipetting by mouth is strictly forbidden. Each student must be provided with a pipette bulb or pipette filler.

Rules for Handling Materials

1. Specific instructions for handling hazardous materials will be included by the host country in the procedures of the practical exam. All potentially dangerous materials will be labeled using the GHS symbols. Each student is responsible for recognizing these symbols and knowing their meaning (see Appendix B).
2. Do not indiscriminately dispose chemicals in the sink. Follow all disposal rules provided by the host country.

A 2: SAFETY RULES AND RECOMMENDATIONS FOR THE HOST COUNTRY OF THE INTERNATIONAL CHEMISTRY OLYMPIAD

Certainly it can be assumed that all students participating in the IChO have at least modest experience with safety laboratory procedures. However, it is the responsibility of the International Jury and the organizing country to be sure that the welfare of the students is carefully considered. Reference to the Safety Rules for Students in the Laboratory will show that the students carry some of the burden for their own safety. Other safety matters will vary from year to year, depending on practical tasks. The organizers of these tasks for the host country are therefore assigned responsibility in the areas listed below. The organizers are advised to carefully test the practical tasks 9 in advance to ensure the safety of the experiments. This can best be accomplished by having students of ability similar to that of IChO participants carry out the testing.

Rules for the Host Country (see also A 1):

1. Emergency first-aid treatment should be available during the practical examination.
2. Students must be informed about the proper methods of handling hazardous materials.

a) Specific techniques for handling each hazardous substance should be included in the written instructions of the practical examination.

b) All bottles (containers) containing hazardous substances must be appropriately labeled using internationally recognized symbols (see Appendix B).

3. Chemical disposal instructions should be provided to the students within the written instructions of the practical examination. Waste collection containers should be used for the chemicals considered hazardous to the environment.
4. The practical tasks should be designed for appropriate (in other words, minimum) quantities of materials.
5. The laboratory facilities should be chosen with the following in mind:
a) Each student should not only have adequate space in which to work, but should be in safe distance from other students.
b) There should be adequate ventilation in the rooms and a sufficient number of hoods when needed.
c) There should be more than one emergency exit for each room.
d) Fire extinguishers should be nearby.
e) Electrical equipment should be situated in an appropriate spot and be of a safe nature.
f) There should be appropriate equipment available for clean-up of spills.
6. It is recommended that one supervisor be available for every four students in the laboratory to adequately ensure safe conditions.
7. The organizers should follow international guidelines for the use of toxic, hazardous or carcinogenic substances in the IChO.

APPENDIX B
HAZARD WARNING SYMBOLS AND HAZARD DESIGNATIONS

Chemicals used in the IChO laboratory experiments need to be labeled according to the Globally Harmonized System of Labelling of Chemicals (GHS) standard developed by the United Nations. The organizing country should use the locally legislated GHS system (pictograms, hazard statements, etc.) if it exists. If such rules do not exist, the original GHS directives (http://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html) and the GHS compliant documentation by the chemical providers should be used. 11

Appendix C

Concepts and skills expected to be known by all participants:

(predominantly equivalent to former number 1 and 2 topics)

Concepts

Awareness of experimental errors, use of significant figures;
Maths skills commonly encountered at secondary school level, including solving quadratic equations, use of logarithms and exponentials, solving simultaneous equations with 2 unknowns, the meaning of sine and cosine, elementary geometry such as Pythagoras' theorem, plotting graphs
(more advanced maths skills such as differentiation and integration, if required must be included as one of the advanced topics)
Nucleons, isotopes, radioactive decay and nuclear reactions (alpha, beta, gamma);
Quantum numbers (n,l,m) and orbitals (s,p,d) in hydrogen-like atoms;
Hund's rule, Pauli exclusion principle;
Electronic configuration of main group and the first row transition metal atoms and their ions;
Periodic table and trends (electronegativity, electron affinity, ionization energy, atomic and ionic size, melting points, metallic character, reactivity);
Bond types (covalent, ionic, metallic), intermolecular forces and relation to properties;
Molecular structures and simple VSEPR theory (up to 4 electron pairs);
Balancing equations, empirical formulae, mole concept and Avogadro constant, stoichiometric calculations, density, calculations with different concentration units;
Chemical equilibrium, Le Chatelier's principle, equilibrium constants in terms of concentrations, pressures and mole fractions;
Arrhenius and Bronsted acid-base theory, pH, self ionization of water, equilibrium constants of acid-base reactions, pH of weak acid solutions, pH of very dilute solutions and simple buffer solutions, hydrolysis of salts;
Solubility constants and solubility;
Complexation reactions, definition of coordination number, complex formation constants;
Basics of electrochemistry: Electromotive force, Nernst equation; Electrolysis, Faraday's laws;
Rate of chemical reactions, elementary reactions, factors affecting the reaction rate, rate law for homogeneous and heterogeneous reactions, rate constant, reaction order, reaction energy profile, activation energy, catalysis, influence of a catalyst on thermodynamic and kinetic characteristics of a reaction;
Energy, heat and work, enthalpy and energy, heat capacity, Hess' law, standard formation enthalpies, solution, solvation and bond enthalpies; Definition and concept of entropy and Gibbs' energy, second law of thermodynamics, direction of spontaneous change;
Ideal gas law, partial pressures;
Principles of direct and indirect titration (back titration);
Acidi- and alkalimetry, acidimetric titration curves, choice and color of indicators for acidimetry;
Redox titrations (permanganometric and iodometric);
Simple complexometric and precipitation titrations;
Basic principles of inorganic qualitative analysis for ions specified in factual knowledge, flame tests;
Lambert-Beer law;
Organic structure-reactivity relations (polarity, electrophilicity, nucleophilicity, inductive effects, relative stability)
Structure-property relations (boiling point, acidity, basicity);
Simple organic nomenclature;
Hybridization and geometry at carbon centers;
Sigma and pi bonds, delocalization, aromaticity, mesomeric structures;
Isomerism (constitutional, configuration, conformation, tautomerism)
Stereochemistry (E-Z, cis-trans isomers, chirality, optical activity, Cahn-Ingold-Prelog system, Fisher projections);
Hydrophilic and hydrophobic groups, micelle formation;

Polymers and monomers, chain polymerizations, polyaddition and polycondensation;

Laboratory skills

Heating in the laboratory, heating under reflux;
Mass and volume measurement (with electronic balance, measuring cylinder, pipette and burette, volumetric flask);
Preparation and dilution of solutions and standard solutions;
Operation of a magnetic stirrer;
Carrying out of test tube reactions;
Qualitative testing for organic functional groups (using a given procedure);
Volumetric determination, titrations, use of a pipette bulb;
Measurement of pH (by pH paper or calibrated pH meter);

Examples of concepts and skills allowed in the exam only if included and demonstrated in the preparatory problems

6 theoretical and 2 practical topics from these or other topics of similar breadth are allowed in a preparatory problem set. It is intended that a topic can be introduced and discussed in a lecture of 2-3 hours before a prepared audience.

- VSEPR theory in detail (with more than 4 ligands);
- Inorganic stereochemistry, isomerism in complexes;
- Solid state structures (metals, NaCl, CsCl) and Bragg's law;
- Relation of equilibrium constants, electromotive force and standard Gibbs energy;
- Integrated rate law for first order reactions, half-life, Arrhenius equation, determination of activation energy;
- Analysis of complex reactions using steady-state and quasi-equilibrium approximations, mechanisms of catalytic reactions, determination of reaction order and activation energy for complex reactions;
- Collision theory
- Simple phase diagrams and the Clausius-Clapeyron equation, triple and critical points;
- Stereoselective transformations (diastereoselective, enantioselective), optical purity
- Conformational analysis, use of Newman projections, anomeric effect
- Aromatic nucleophilic substitution, electrophilic substitution on polycyclic aromatic compounds and heterocycles
- Supramolecular chemistry
- Advanced polymers, rubbers, copolymers, thermosetting polymers. Polymerization types, stages and kinetics of polymerization;
- Amino acid side groups, reactions and separation of amino acids, protein sequencing;
- Secondary, tertiary and quaternary structures of proteins, non-covalent interactions, stability and denaturation, protein purification by precipitation, chromatography and electrophoresis;
- Enzymes and classification according to reaction types, active sites, coenzymes and cofactors, mechanism of catalysis;
- Monosaccharides, equilibrium between linear and cyclic forms, pyranoses and furanoses, Haworth projection and conformational formulae;
- Chemistry of carbohydrates, oligo- and polysaccharides, glycosides, determination of structure;
- Bases, nucleotides and nucleosides with formulae, Functional nucleotides, DNA and RNA, hydrogen bonding between bases, replication, transcription and translation, DNA based applications;
- Complex solubility calculations (with hydrolyzing anions, complex formation);
- Simple Schrödinger equations and spectroscopic calculations;
- Simple MO theory;
- Basics of mass spectrometry (molecular ions, isotope distributions);
- Interpretation of simple NMR spectra (chemical shift, multiplicity, integrals);
- Synthesis techniques: filtrations, drying of precipitates, thin layer chromatography.

• Synthesis in microscale equipment;
• Advanced inorganic qualitative analysis;
• Gravimetric analysis;
• Use of a spectrophotometer;
• Theory and practice of extraction with immiscible solvents;
• Column chromatography;

Appendix D

Outline of the factual knowledge supposed to be known by the competitors:

Reactions of s-block elements with water, oxygen and halogens, their color in flame tests;
Stoichiometry, reactions and properties of binary non-metal hydrides;
Common reactions of carbon, nitrogen and sulfur oxides (CO, CO_2, NO, NO_2, N_2O_4, SO_2, SO_3);
Common oxidation states of p-block elements, stoichiometry of common halides and oxoacids (HNO_2, HNO_3, H_2CO_3, H_3PO_4, H_3PO_3, H_2SO_3, H_2SO_4, HOCl, $HClO_3$, $HClO_4$);
Reaction of halogens with water;
Common oxidation states of first row transition metals (Cr(III), Cr(VI), Mn(II), Mn(IV), Mn(VII), Fe(II), Fe(III), Co(II), Ni(II), Cu(I), Cu(II), Ag(I), Zn(II), Hg(I), and Hg(II))and the color of these ions;
Dissolution of these metals and Al, amphoteric hydroxides ($Al(OH)_3$, $Cr(OH)_3$, $Zn(OH)_2$);
Permanganate, chromate, dichromate ions and their redox reactions;
Iodometry (reaction of thiosulfate and iodine);
Identification of Ag^+, Ba^{2+}, Fe^{3+}, Cu^{2+}, Cl^-, CO_3^{2-}, SO_4^{2-} ;
Organic:
Common electrophiles and nucleophiles
Electrophilic addition: addition to double and triple bonds, regioselectivity (Markovnikoff's rule), stereochemistry
Electrophilic substitution: substitution on aromatic rings, influence of substituents on the reactivity and regioselectivity, electrophilic species;
Elimination: E1 and E2 reactions at sp^3 carbon centers, stereochemistry, acid-base catalysis, common leaving groups;
Nucleophilic substitution: SN1 and SN2 reactions at sp^3 carbon centers, stereochemistry;
Nucleophilic addition: addition to carbon-carbon and carbon-hetero atom double and triple bonds, addition-elimination reactions, acid-base catalysis;
Radical substitution: reaction of halogens and alkanes;
Oxidations and reductions: switching between the different oxidation levels of common functional groups (alkyne – alkene – alkane – alkyl halide, alcohol – aldehyde, ketone – carboxylic acid derivatives, nitriles – carbonates)
Cyclohexane conformations;
Grignard reaction, Fehling and Tollens reaction;
Simple polymers and their preparation (polystyrene, polyethylene, polyamides, polyesters);
Amino acids and their classification in groups, isoelectric point, peptide bond, peptides and proteins;
Carbohydrates: open chain and cyclic form of glucose and fructose;
Lipids: general formulae of triacyl glycerides, saturated and unsaturated fatty acids;