Syllabus of the International Chemistry Olympiad

Level 1: These topics are included in the overwhelming majority of secondary school chemistry programs and need not to be mentioned in the preparatory problems.

Level 2: These topics are included in a substantial number of secondary school programs and maybe used without exemplification in the preparatory problems.

Level 3: These topics are not included in the majority of secondary school programs and can only be used in the competition if examples are given in the preparatory problems.

1 INORGANIC CHEMISTRY

1.1 Electronic configuration of atoms and ions

1.1.1	main groups	1
1.1.2	transition metals	2
1.1.3	lanthanide and actinide metals	3
1.1.4	Pauli exclusion principle	1
1.1.5	Hund's rule	1

1.2 Trends in the periodic table (main groups)

1.2.1	electronegativity	1
1.2.2	electron affinity	2
1.2.3	first ionisation energy	2
1.2.4	atomic size	1
1.2.5	ionic size	2
1.2.6	highest oxidation number	1

1.3 Trends in physical properties (main groups)

1.3.1	melting point	1
1.3.2	boiling point	1
1.3.3	metal character	1
1.3.4	magnetic properties	2
1.3.5	thermal properties	3
1.3.6	law of Dulong and Petit	1
1.3.7	electrical conductivity	3

1.4 Structures

1.4.1	simple molecular structures	2
1.4.2	simple molecular structures with a central atom exceeding the octet rule	3
1.4.3	ionic crystal structures	3
1.4.4	metal structures	3
1.4.5	stereochemistry	3

1.5 Nomenclature

1.5.1	oxidation number	1
1.5.2	main group compounds	1
1.5.3	transition metal compounds	1
1.5.4	simple metal complexes	2
1.5.5	multicenter metal complexes	3

1.6 Chemical calculations

1.6.1	balancing equations	1
1.6.2	stoichiometric calculations	1
1.6.3	mass and volume relations	1
1.6.4	empirical formula	1
1.6.5	Avogadro's number	1
1.6.6	concentration calculations	1

1.7 Isotopes

1.7.1	counting of nucleons	1
1.7.2	radioactive decay	1
1.7.3	nuclear reactions (alpha, beta, gamma,neutrino)	2

1.8 Natural cycles

1.8.1	nitrogen	2
1.8.2	oxygen	2
1.8.3	carbon	2

1.9 s-Block

1.9.1	Products of reactions of group I and II metals	
1.9.1.1	with water, basicity of the products	1
1.9.1.2	with halogens	1
1.9.1.3	with oxygen	2
1.9.2	heavier s-block elements are more reactive	1
1.9.3	lithium combines with H_2 and N_2 forming LiH and Li_3N	2

1.10 p-Block

1.10.1	stoichiometry of simplest non-metal hydrides	1
1.10.2	properties of metal hydrides	3
1.10.3	acid-base properties of CH_4, NH_3, H_2O, H_2S, and hydrogen halides HX	1
1.10.4	NO reacts with O_2 to form NO_2	1
1.10.5	equilibrium between NO_2 and N_2O_4	1

1.10.6 products of reaction of NO_2 with water 1
1.10.7 HNO_2 and its salts are reductants 1
1.10.8 HNO_3 and its salts are oxidants 1
1.10.9 N_2H_4 is a liquid and reluctant 3
1.10.10 existence of acids like $H_2N_2O_2$, HN_3 3
1.10.11 reactions of HNO_3 with different metals and reductants 3
1.10.12 reaction of $Na_2S_2O_3$ with iodine 2
1.10.13 other thioacids, polyacids, peroxoacids 3
1.10.14 B(III), Al(III), Si(IV), P(V), S(IV), S(VI), O(-II), F(-I), Cl(-I), Cl(I), Cl(III), Cl(V), Cl(VII) are normal oxidation states of 2nd and 3rd row elements in compounds with halogens and in oxoanions 1
1.10.15 compounds of non-metals with other oxidation states 3
1.10.16 the preferred oxidation states are Sn(II), Pb(II) and Bi(III) 2
1.10.17 products of reactions of non-metal oxides with water and stoichiometry of resulting acids 1
1.10.18 reactions of halogens with water 2
1.10.19 reactivity and oxidizing power of halogens decrease from F_2 to I_2 1
1.10.20 differences of chemistry between row 4 and row 3 elements 3

1.11 d-Block

1.11.1 common oxidation states of the common d-block metals are 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) 1
1.11.2 colors of the listed common ions in aqueous solutions 2
1.11.3 other oxidation states and chemistry of other d-block elements 3
1.11.4 Cr, Mn, Fe, Co, Ni, Zn dissolve in dilute HCl; Cu, Ag, Hg do not dissolve 1
1.11.5 products of dissolution are (2+) cations 2
1.11.6 passivation of Cr, Fe (and also Al) 2
1.11.7 $Cr(OH)_3$ and $Zn(OH)_2$ are amphoteric, other common hydroxides are not 1
1.11.8 MnO_4^-, CrO_4^{2-}, $Cr_2O_7^{2-}$ are strong oxidants 1
1.11.9 products of reduction of MnO_4^- depending on pH 2
1.11.10 polyanions other than $Cr_2O_7^{2-}$ 3

1.12 Other inorganic problems

1.12.1 industrial production of H_2SO_4, NH_3, Na_2CO_3, Na, Cl_2, NaOH, 1
1.12.2 chemistry of lanthanides and actinides 3
1.12.3 chemistry of noble gases 3

2. PHYSICAL CHEMISTRY

2.1 Chemical equilibria

2.1.1 dynamical model of chemical equilibria 1
2.1.2 chemical equilibria expressed in terms of relative concentrations 1
2.1.3 chemical equilibria expressed in terms of partial pressures 2
2.1.4 the relationship between equilibrium constants for ideal gases expressed in different ways (concentration, pressure, mole fraction) 3
2.1.5 relation of equilibrium constant and standard Gibbs energy 3

2.2 Ionic equilibria

2.2.1 Arrhenius theory of acids and bases 1
2.2.2 Broensted-Lowry theory, conjugated acids and bases 1
2.2.3 definition of pH 1
2.2.4 ionic product of water 1
2.2.5 relation between K_a and K_b for conjugated acids and bases 1
2.2.6 hydrolysis of salts 1
2.2.7 solubility product - definition 1
2.2.8 calculation of solubility (in water) from solubility product 1
2.2.9 calculation of pH for weak acids from K_a 1
2.2.10 calculation of pH for 10^{-7} mol dm^{-3} HCl solution 2
2.2.11 calculation of pH for multiprotic acids 2
2.2.12 calculation of pH for weak acid mixtures 3
2.2.13 definition of activity coefficient 2
2.2.14 definition of ionic strength 3
2.2.15 Debye-Hückel formula 3

2.3 Electrode equilibria

2.3.1 electromotive force (definition) 1
2.3.2 first kind electrodes 1
2.3.3 standard electrode potential 1
2.3.4 Nernst equation 2
2.3.5 second kind electrodes 2
2.3.6 relation between ΔG and electromotive force 3

2.4 Kinetics of homogeneous reactions

2.4.1 factors influencing reaction rate 1
2.4.2 rate equation 1
2.4.3 rate constant 1
2.4.4 order of reactions 2
2.4.5 1st order reactions: time dependence of concentration 2
2.4.6 1st order reactions: half life 2
2.4.7 1st order reactions: relation between half-life and rate constant 2
2.4.8 rate-determining step 2
2.4.9 molecularity 2
2.4.10 Arrhenius equation, activation energy (definition) 2
2.4.11 calculation of rate constant for 1st order reaction 2
2.4.12 calculation of rate constant for second and third order reactions 3
2.4.13 calculation of activation energy from experimental data 3
2.4.14 basic concepts of collision theory 3
2.4.15 basic concepts of transition state

	theory	3
2.4.16	opposing, parallel and consecutive reactions	3

2.5 Thermodynamics (First law)

2.5.1	system and its surroundings	2
2.5.2	energy, heat and work	2
2.5.3	relation between enthalpy and energy	2
2.5.4	heat capacity - definition	2
2.5.5	difference between C_p and C_v (ideal gas only)	2
2.5.6	Hess law	2
2.5.7	Born-Haber cycle for ionic compounds	3
2.5.8	lattice energies - approximate calculations (e.g. Kapustinski equation)	3
2.5.9	use of standard formation enthalpies	2
2.5.10	heats of solution and solvation	2
2.5.11	bond energies - definition and uses	2

2.6 Thermodynamics (Second law)

2.6.1	entropy, definition (q/T)	2
2.6.2	entropy and disorder	2
2.6.3	relation $S = k \ln W$	3
2.6.4	relation $\Delta G = \Delta H - T\Delta S$	2
2.6.5	ΔG and directionality of changes	2

2.7 Phase systems

2.7.1	ideal gas law	1
2.7.2	van der Waals gas law	3
2.7.3	definition of partial pressure	1
2.7.4	temperature dependence of the vapor pressure of liquid	2
2.7.5	Clausius-Clapeyron equation	3
2.7.6	reading phase diagrams: triple point	3
2.7.7	phase diagrams: critical temperature	3
2.7.8	liquid-vapor system (diagram)	3
2.7.9	liquid-vapor: ideal and non-ideal systems	3
2.7.10	liquid-vapor: use in fractional distillation	3
2.7.11	Henry's law	2
2.7.12	Raoult's law	2
2.7.13	deviations from Raoult's law	3
2.7.14	boiling point elevation law	2
2.7.15	freezing point depression, determination of molar mass	2
2.7.16	osmotic pressure	2
2.7.17	partition coefficient	3
2.7.18	solvent extraction	3
2.7.19	basic principles of chromatography	2

3. ORGANIC CHEMISTRY

3.1 Alkanes

3.1.1	isomers of butane	1
3.1.2	naming (IUPAC)	1
3.1.3	trends in physical properties	1
3.1.4	Substitution (e.g. with Cl_2)	
3.1.4.1	products	1
3.1.4.2	free radicals	2
3.1.4.3	initiation/termination of the chain reaction	2

3.2 Cycloalkanes

3.2.1	names	1
3.2.2	strain in small rings	2
3.2.3	chair/boat conformation	2

3.3 Alkenes

3.3.1	planarity	1
3.3.2	*E*/*Z* (*cis-trans*) isomerism	1
3.3.3	Addition of Br_2 and HBr	
3.3.3.1	products	1
3.3.3.2	Markovnikov's rule	2
3.3.3.3	carbonium ions in addition reactions	3
3.3.3.4	relative stability of carbonium ions	3
3.3.3.5	1,4-addition to alkadienes	3

3.4 Alkynes

3.4.1	linear geometry	1
3.4.2	acidity	2
3.4.3	differences in chemical properties between alkenes and alkynes	3

3.5 Arenes and heterocycles

3.5.1	formula of benzene	1
3.5.2	delocalization of electrons	1
3.5.3	stabilization by resonance	1
3.5.4	Hückel (4n + 2) rule	3
3.5.5	aromaticity of heterocycles	3
3.5.6	nomenclature of heterocycles (IUPAC)	3
3.5.7	polycyclic aromatic compounds	3
3.5.8	effect of first substituent on reactivity	2
3.5.9	effect of first substituent on direction of substitution	2
3.5.10	explanation of substituent effects	3

3.6 Halogen compounds

3.6.1	hydrolytic reactions	2
3.6.2	exchange of halogens	3
3.6.3	reactivity (primary vs secondary vs tertiary)	2
3.6.4	ionic mechanism of substitution	2
3.6.5	side products (elimination)	2
3.6.6	reactivity (aliphatic vs aromatic)	2
3.6.7	Wurtz (RX + Na) reaction	3
3.6.8	halogen derivatives and pollution	3

3.7 Alcohols and phenols

3.7.1	hydrogen bonding - alcohols vs ethers	1
3.7.2	acidity of alcohols vs phenols	2
3.7.3	dehydration to alkenes	1
3.7.4	dehydration to ethers	2
3.7.5	esters with inorganic acids	2
3.7.6	iodoform reaction	2
3.7.7	reactions of primary/secondary/ tertiary: Lucas reagent	2
3.7.8	formula of glycerol	1

3.8 Carbonyl compounds

3.8.1	nomenclature	1
3.8.2	keto/enol tautomerism	2
3.8.3	Preparation of carbonyl compounds	
3.8.3.1	oxidation of alcohols	1
3.8.3.2	from carbon monoxide	3

3.8.4	Reaction of carbonyl compounds	
3.8.4.1	oxidation of aldehydes	1
3.8.4.2	reduction with Zn metal	2
3.8.4.3	addition of HCN	2
3.8.4.4	addition of $NaHSO_3$	2
3.8.4.5	addition of NH_2OH	2
3.8.4.6	aldol condensation	3
3.8.4.7	preparation of acetates	2
3.8.4.8	Cannizzaro (PhCHO disproportionation)	3
3.8.4.9	Grignard reaction	2
3.8.4.10	Fehling (Cu_2O) and Tollens (Ag mirror) reagents	2

3.9 Carboxylic acids

3.9.1	inductive effect and strength	2
3.9.2	equivalence of oxygen atoms in anions	2
3.9.3	Preparation and reactions of carboxylic acids	
3.9.3.1	preparation from esters	2
3.9.3.2	preparation from nitriles	2
3.9.3.3	products of reaction with alcohols (esters)	3
3.9.3.4	mechanism of esterification	2
3.9.3.5	isotopes in mechanism elucidation	3
3.9.3.6	nomenclature of acid halides	2
3.9.3.7	preparation of acid chlorides	2
3.9.3.8	preparation of amides from acid chlorides	2
3.9.3.9	preparation of nitriles from acid chlorides	3
3.9.3.10	properties and preparation of anhydrides	2
3.9.3.11	oxalic acid, name and formula	1
3.9.3.12	multifunctional acids (e.g. hydroxy acids, keto acids)	2
3.9.3.13	polycarboxylic acids	2
3.9.3.14	optical activity (e.g. lactic acid)	2
3.9.3.15	*R*/*S* nomenclature	3
3.9.3.16	plant and animal fats, differences	2

3.10 Nitrogen compounds

3.10.1	basicity of amines	1
3.10.2	comparing aliphatic vs. aromatic	2
3.10.3	names: primary, secondary, tertiary, quaternary amines	2
3.10.4	identification of primary/sec./tert./ quaternary amines in the laboratory	3
3.10.5	Preparation of amines	
3.10.5.1	from halogen compounds	2
3.10.5.2	from nitro compounds (e.g. $PhNH_2$ from $PhNO_2$)	3
3.10.5.3	from amides (Hoffmann)	3
3.10.6	mechanism of Hoffmann rearrangement in acidic/basic medium	3
3.10.7	basicity amines vs. amides	2
3.10.8	diazotation products of aliphatic amines	3
3.10.9	diazotation products of aromatic amines	3
3.10.10	dyes: color vs. structure (chromophore groups)	3
3.10.11	nitro compounds : aci/nitro tautomerism	3
3.10.12	Beckmann (oxime - amide) rearrangements	3

3.11 Some large molecules

3.11.1	hydrophilic/hydrophobic groups	2
3.11.2	micelle structure	3
3.11.3	preparation of soaps	1
	products of polymerization of:	
3.11.4	- styrene	2
3.11.5	- ethene	1
3.11.6	- polyamides	3
3.11.7	- phenol + aldehydes	3
3.11.8	- polyurethanes	3
3.11.9	polymer cross linking	3
3.11.10	chain mechanism of polymer formation	2
3.11.11	rubber composition	3

4. BIOCHEMISTRY

4.1 Amino acids and peptides

4.1.1	ionic structure of amino acids	1
4.1.2	isoelectric point	2
4.1.3	20 amino acids (classification in groups)	2
4.1.4	20 amino acids (names and structures)	3
4.1.5	ninhydrin reaction (including equation)	3
4.1.6	separation by chromatography	3
4.1.7	separation by electrophoresis	3
4.1.8	peptide linkage	1

4.2 Proteins

4.2.1	primary structure of proteins	1
4.2.2	-S-S- bridges	3
4.2.3	sequence analysis	3
4.2.4	secondary structures	3
4.2.5	details of alpha-helix structure	3
4.2.6	tertiary structure	3
4.2.7	denaturation reaction by change of pH, temperature, metals, ethanol	2
4.2.8	quaternary structure	3
4.2.9	separation of proteins (molecule size and solubility)	3
4.2.10	metabolism of proteins (general)	3
4.2.11	proteolysis	3
4.2.12	transamination	3
4.2.13	four pathways of catabolism of amino acids	3
4.2.14	decarboxylation of amino acids	3
4.2.15	urea cycle (only results)	3

4.3 Fatty acids and fats

4.3.1	IUPAC names from C_4 to C_{18}	2
4.3.2	trivial names of most important (ca. 5) fatty acids	2
4.3.3	general metabolism of fats	2
4.3.4	beta-oxidation of fatty acids (formulae and ATP balance)	3
4.3.5	fatty acids and fats anabolism	3
4.3.6	phosphoglycerides	3

4.3.7	membranes	3
4.3.8	active transport	3

4.4 Enzymes

4.4.1	general properties, active centres	2
4.4.2	nomenclature, kinetics, coenzymes, function of ATP, etc.	3

4.5 Saccharides

4.5	Glucose and fructose:	
4.5.1	- chain formulas	2
4.5.2	- Fischer projections	2
4.5.3	- Haworth formulas	3
4.5.4	osazones	3
4.5.5	maltose as reducing sugar	2
4.5.6	difference between starch and cellulose	2
4.5.7	difference between alpha- and beta-D glucose	2
4.5.8	metabolism from starch to acetyl-CoA	3
4.5.9	pathway to lactic acid or to ethanol; catabolism of glucose	3
4.5.10	ATP balance for the above pathways	3
4.5.11	photosynthesis (products only)	2
4.5.12	light and dark reaction	3
4.5.13	detailed Calvin cycle	3

4.6 Krebs cycle and respiration chain

4.6.1	formation of CO_2 in the cycle (no details)	3
4.6.2	intermediate compounds in the cycle	3
4.6.3	formation of water and ATP (no details)	3
4.6.4	FMN and cytochromes	3
4.6.5	calculation of ATP amount for 1 mole of glucose	3

4.7 Nucleic acids and protein synthesis

4.7.1	pyrimidines, purines	2
4.7.2	nucleosides and nucleotides	3
4.7.3	formulae of all pyrimidine and purine bases	3
4.7.4	difference between ribose and 2-deoxyribose	3
4.7.5	base combination CG and AT	3
4.7.6	base combination CG and AT (hydrogen bonding structure)	3
4.7.7	difference between DNA and RNA	3
4.7.8	difference between mRNA and tRNA	3
4.7.9	hydrolysis of nucleic acids	3
4.7.10	semiconservative replication of DNA	3
4.7.11	DNA-ligase	3
4.7.12	RNA synthesis (transcription) without details	3
4.7.13	reverse transcriptase	3
4.7.14	use of genetic code	3
4.7.15	start and stop codons	3
4.7.16	translation steps	3

4.8 Other biochemical problems

4.8.1	hormones, regulation	3
4.8.2	hormones, feedback	3
4.8.3	insulin, glucagon, adrenaline	3
4.8.4	mineral metabolism (no details)	3
4.8.5	ions in blood	3
4.8.6	buffers in blood	3
4.8.7	haemoglobin; function and skeleton	3
4.8.8	haemoglobin; diagram of oxygen absorption	3
4.8.9	steps in clotting the blood	3
4.8.10	antigens and antibodies	3
4.8.11	blood groups	3
4.8.12	acetyl choline, structure and functions	3

OTHER PROBLEMS

5. Analytical chemistry

5.1	choice of indicators for acidimetry	1
5.2	titration curve; pH (strong and weak acid)	2
5.3	EMF (redox titration)	2
5.4	calculation of pH of simple buffer solution	2
5.5	identification of Ag^+, Ba^{2+}, Cl^-, SO_4^{2-}	1
5.6	identification of Al^{3+}, NO_2^-, NO_3^-, Bi^{3+}	2
5.7	identification of VO_3^-, ClO_3^-, Ti^{4+}	3
5.8	use of flame tests for identification of K, Ca and Sr	1
5.9	Lambert -Beer law	2

6. Complexes

6.1	writing down complexation reactions	1
6.2	definition of coordination number	1
6.3	prediction of coordination number of complex ions and molecules	3
6.4	complex formation constants (definition)	2
6.5	E_g and T_{2g} terms: high and low spin octahedral complexes	3
6.6	calculation of solubility of AgCl in NH_3 (from K_s and constants β)	3
6.7	*cis* and *trans* forms	3

7. Theoretical chemistry

7.1	energy levels of hydrogen atom (formula)	2
7.2	square of the wave function and probability	3
7.3	understanding the simplest Schrödinger equation	3
7.4	n, l, m quantum numbers	2
7.5	shape of p-orbitals	2
7.6	d-orbital stereoconfiguration	3
7.7	molecular orbital diagram: H_2 molecule	2
7.8	molecular orbital diagram: N_2 and O_2 molecules	3
7.9	bond orders in O_2, O_2^+, O_2^-	3
7.10	unpaired electrons and paramagnetism	2
7.11	Hückel theory for aromatic compounds	3
7.12	Lewis acids and bases	2
7.13	hard and soft Lewis acids	3

8. Instrumental methods of determining structure

8.1 UV-VIS spectroscopy

8.1.1	identification of aromatic compound	3
8.1.2	identification of chromophores	3

8.2 Mass spectra

8.2	recognition of:	
8.2.1	- molecular ions	3
8.2.2	- fragments with the help of a table	3
8.2.3	typical isotope distribution	3

8.3 Infrared spectra

8.3.1	interpretation using a table of group frequencies	3
8.3.2	recognition of hydrogen bonds	3
8.3.3	Raman spectroscopy	3

8.4 NMR

8.4.1	interpretation of a simple spectrum (like ethanol)	3
8.4.2	spin-spin coupling	3
8.4.3	coupling constants	3
8.4.4	identification of *o*- and *p*- substituted benzene	3
8.4.5	^{13}C- NMR	3

8.5 X-rays

8.5.1	Bragg's law	3
8.5.2	electron density diagram	3
8.5.3	coordination number	3
8.5.4	unit cell	3
	structures:	
8.5.5	- of NaCl	3
8.5.6	- of CsCl	3
8.5.7	- close-packed (2 types)	3
8.5.8	determining of the Avogadro constant from X-ray data	3

8.6 Polarimetry

8.6.1	calculation of specific rotation angle	3

Syllabus for the experimental part of the IChO competition

Level 1 is assigned to the basic experimental activities which are supposed to be mastered very well by competitors.
Level 2 is assigned to the activities which are parts of school experimental exercises in developed countries and the authors of IChO tasks may incorporate them into the tasks without being bound to mention it in advance.
Level 3 is assigned to such activities which are not in the chemistry syllabus in the majority of participating countries and the authors are obliged to mention them in the set of preparatory tasks.

1. Synthesis of inorganic and organic compounds

1.1	heating with burners and hotplates	1
1.2	heating of liquids	1
1.3	handling of inflammable substances and materials	1
1.4	measuring of masses (analytical balance)	1
1.5	measuring of volumes of liquids (measuring cylinder, pipette, burette)	1
1.6	preparation of solutions from a solid compound and solvent	1
1.7	mixing and dilution of solutions	1
1.8	mixing and stirring of liquids	1
1.9	using mixer and magnetic stirrer	2
1.10	using a dropping funnel	1
1.11	syntheses in flat bottom vessels - general principles	1
1.12	syntheses in round bottom vessels - general principles	1
1.13	syntheses in a closed apparatus - general principles	1
1.14	using micro scale equipment for synthesis	3
1.15	apparatus for heating of a reaction mixture under reflux	2
1.16	apparatus for distillation of liquids at normal pressure	2
1.17	apparatus for distillation of liquids at reduced pressure	3
1.18	apparatus for steam distillation	3
1.19	filtration through flat paper filter	1
1.20	filtration through a folded paper filter	1
1.21	handling a water vacuum pump	1
1.22	filtration through a Büchner funnel	1
1.23	suction through a glass filter	1
1.24	washing of precipitates by decantation	1
1.25	washing of precipitates on a filter	2
1.26	drying of precipitates on a filter with appropriate solvents	2
1.27	recrystallization of substances from aqueous solution	1
1.28	recrystallization of substances from a known organic solvent	2
1.29	practical choice of an appropriate solvent for recrystallization of a substance	3
1.30	drying of substances in a drying box	2
1.31	drying of substances in a desiccator	2
1.32	connecting and using a gas washing bottle	2
1.33	extraction with an immiscible solvent	1

2. Identification of inorganic and organic compounds - general principles

2.1	test-tube reactions	1
2.2	technique of reactions performed in a dot dish and on a filter paper	1
2.3	group reactions of some cations and anions specified by the organizer	2
2.4	selective reactions of some cations and anions specified by the organizer	2
2.5	specific reactions of some cations and anions specified by the organizer	3
2.6	identification of elements by flame coloration (using a platinum wire/ MgO rod, Co-glass)	2
2.7	using a hand spectroscope/Bunsen spectroscope	3
2.8	melting point determination with Kofler or similar type of apparatus	3
2.9	qualitative evidence of basic functional groups of organic substances specified by the organizer	2
2.10	exploitation of some specific reactions for identification of organic compounds (specified by the organizer)	3

3. Determination of some inorganic and organic compounds - general principles

3.1	quantitative determinations using precipitation reactions	2
3.2	igniting of a precipitate in a crucible	1
3.3	quantitative volumetric determinations	1
3.4	rules of titrations	1
3.5	use of a pipetting ball	1
3.6	preparation of a standard solution	2
3.7	alkalimetric and acidimetric determinations	2
3.8	color transitions of indicators at alkalimetric and acidimetric determinations	2
3.9	direct and indirect determinations (back titration)	3
3.10	manganometric determinations	3
3.11	iodometric determinations	3
3.12	other types of determinations on basis of redox reactions	3
3.13	complexometric determinations	3
3.14	color transitions of solutions at complexometric determinations	3
3.15	volumetric determinations on basis of precipitation reactions	3
3.16	thermometric titration	3

4. Special measurements and procedures

4.1	measuring with a pH-meter	2
4.2	chromatography on thin layers	3
4.3	column chromatography	3
4.4	separation on ion exchanger	3
4.5	measuring of UV-VIS absorbances with a spectral photometer	3
4.6	performing of conductivity measurements	3

5. Evaluation of results

5.1	Estimation of experimental errors (significant figures, plots scales)	1

6. If the organizer wants to apply a technique which is not mentioned in the above syllabus, this technique is set to level 3 automatically.