

Undergraduate Track Program: Chemistry and Materials Sciences

1. Olympiad Winner's Skill Set

To win the Olympiad, you should have a firm grasp of computer chemistry, physics and mathematics, namely:

- basic theoretical principles of the main fundamental branches of chemistry (general and inorganic chemistry, physical chemistry, organic chemistry)
- crystalline structure of matter and the connection between the structure of substances and materials and their physical, chemical and operational properties

You should also be able to apply theoretical knowledge to solve practical problems and demonstrate the ability to use interdisciplinary approaches.

You should also have a solid command of the following skills:

- to search, analyze and systematize industry-specific regulatory and technical documentation, peer-reviewed scientific, methodological and other literature using modern libraries and databases.

2. List of degree programs covered by the subject area

2.1 List of bachelor's programs

04.03.02 Chemistry, physics and mechanics of materials

22.03.01 Materials science and materials technology

2.2 List of specialist programs

04.05.01 Fundamental and applied chemistry

18.05.02 Chemical technology of modern energy materials

3. Program Content

Inorganic and nuclear chemistry

Chemistry:

- 1.1. Atomic structure.
- 1.2. Periodic law and D.I. Mendeleev's periodic system of chemical elements.
- 1.3. Electronegativity. Valence. Oxidation state.
- 1.4. Classification of inorganic substances. Nomenclature of inorganic substances.
- 1.5. Types of chemical bonds, theory of hybridization of atomic orbitals.
- 1.6. Chemical reaction. Classification of chemical reactions in inorganic chemistry.
- 1.7. Theory of electrolytic dissociation. Strong and weak electrolytes.
- 1.8. Hydrolysis of salts. Ionic product of water. Hydrogen value (pH) of the solution.
- 1.9. Redox reactions.
- 1.10 Chemical properties of simple substances.
- 1.11. Chemical properties of the main classes of inorganic compounds.

Organic chemistry

Chemistry:

- 2.1. Basic principles of organic chemistry: A.M. Butlerov's theory of chemical structure. Classification and nomenclature of organic compounds.
- 2.2. Saturated hydrocarbons: Nomenclature and isomerism. Reactions of free radical substitution, oxidation, cracking. Methods of obtaining.
- 2.3 Unsaturated hydrocarbons: Homologous series of alkenes and alkynes and their nomenclature. Chemical properties (electrophilic addition reactions, oxidation reactions). Methods of obtaining.

2.4. Aromatic hydrocarbons: Classification, nomenclature and isomerism of arenes. Chemical properties: electrophilic substitution reactions, reduction. Orienting effect of substituents on the benzene ring.

2.5. Oxygen-containing organic compounds: Classification, nomenclature and isomerism of alcohols, aldehydes, carboxylic acids. The most important chemical properties of alcohols, aldehydes, carboxylic acids. Methods of obtaining.

Physical chemistry

Chemistry, physics:

3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes).

3.2. Reversible and irreversible chemical reactions. Chemical balance. Factors influencing the state of chemical equilibrium. Le Chatelier's principle.

3.3. Thermochemistry, Hess's Law.

3.4. Solutions. Methods of expressing the concentration of solutions.

3.5. Electrochemistry.

3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, and methods for its determination.

Analytical chemistry

Chemistry:

4.1. Theoretical foundations of analytical chemistry: Balancing equations of chemical reactions and calculations based on them. Methods for identifying ions in solution (formation of precipitates, gases or colored compounds). Conditions for dissolution and precipitation. Methods for determining the equivalence point in titrimetric methods of analysis.

4.2. The most important chemical properties of compounds of s-elements (Na, K, Mg, Ca, Sr, Ba).

4.3. The most important chemical properties of compounds of p-elements (Al, Si, P, S, Pb, N, Cl).

4.4. The most important chemical properties of d-element compounds (Cr, Mn, Fe, Cu, Zn, Ni).

4.5. Qualitative analysis of solids and solutions: Methods for transferring solids into solution. Classification of ions by analytical groups.

4.6. Quantitative analysis: Gravimetry, titrimetry and its types.

Crystallography

Chemistry:

5.1. Crystalline substance and its properties. The concept of symmetry.

5.2. Crystal symmetry classes. Categories and syngony.

5.3. Types of Bravais lattices.

5.4. Types of chemical bonds in crystals.

Testing in materials sciences

Chemistry, physics:

6.1. Classification, nomenclature and hierarchy of polymers and composites based on them.

6.2. Methods for studying the structure and chemical composition of polymers and composites based on them (optical microscopy, atomic force microscopy, scanning electron microscopy, infrared spectroscopy).

6.3. Methods for studying the physical and mechanical properties of materials (determination of tensile strength, determination of compressive strength, determination of double-support bending strength, determination of impact strength (viscosity), determination of impact strength on two supports (according to Charpy), determination of hardness by indentation of a ball (according to Brinell), determination of heat resistance).

6.4. Methods for studying the operational and special properties of polymers and composites based on them (determination of wear resistance, determination of biostability, determination of light resistance, determination of resistance to liquid aggressive media, determination of abrasion resistance of coatings, wetting of polymers).

6.5. Methods for processing experimental data (measurement errors and their classification; rules for processing the results of direct and indirect measurements; registration of measurement results).

Metallurgy

Chemistry, physics:

7.1. Physical metallurgy.

7.2. Metal production and processing.

7.3. Corrosion and protection of metals.

4. Recommended References

4.1. Reading List

Inorganic and nuclear chemistry

Sources in English	Topic
1. David W. Ball Cleveland State University Introductory Chemistry, Copyright Year: 2011 https://open.umn.edu/opentextbooks/textbooks/22	1.5. Types of chemical bonds, theory of hybridization of atomic orbitals. 1.6. Chemical reaction. Classification of chemical reactions in inorganic chemistry. 1.7. Theory of electrolytic dissociation. Strong and weak electrolytes. 1.8. Hydrolysis of salts. Ionic product of water. Hydrogen value (pH) of the solution. 1.9. Redox reactions.
2. House J.E. Inorganic chemistry. Elsevier 2008. p. 850. ISBN: 978-0-12-356786-4 chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://tech.chemistrydocs.com/Books/InOrganic/Inorganic-Chemistry-by-James-E-House.pdf	1.10 Chemical properties of simple substances. 1.11. Chemical properties of the main classes of inorganic compounds.
3. Lee J.D. Concise Inorganic Chemistry for JEE (Main & Advanced), 4ed. Chapman & Hall, 1991. 718 p. URL://https://zlib.pub/book/jd-lee-concise-inorganic-chemistry-for-jee-main-advanced-12ldgeei8s9o	1.1. Atomic structure. 1.2. Periodic law and D.I. Mendeleev's periodic system of chemical elements. 1.3. Electronegativity. Valence. Oxidation state. 1.4. Classification of inorganic substances. Nomenclature of inorganic substances.
4. Overton T. L., Rourke J. P., Weller M. T., Armstrong F. A. Inorganic chemistry, 7th ed. Great Britain: Oxford University Press, 2018. 967 p URL:https://zlib.pub/book/inorganic-chemistry-71ndlsulje40	1.5. Types of chemical bonds, theory of hybridization of atomic orbitals. 1.6. Chemical reaction. Classification of chemical reactions in inorganic chemistry. 1.7. Theory of electrolytic dissociation. Strong and weak electrolytes. 1.8. Hydrolysis of salts. Ionic product of water. Hydrogen value (pH) of the solution.

	1.9. Redox reactions.
Sources in Russian	Topics
1. Глинка Н. Л. Общая химия: Учебное пособие для вузов. Под ред. А. И. Ермакова. М.: Интеграл-Пресс, 2003. 728 с. URL:https://archive.org/details/B-001-026-834-PDF-025/page/n1/mode/2up (open access)	1.4. Classification of inorganic substances. Nomenclature of inorganic substances. 1.5. Types of chemical bonds, theory of hybridization of atomic orbitals. 1.6. Chemical reaction. Classification of chemical reactions in inorganic chemistry. 1.7. Theory of electrolytic dissociation. Strong and weak electrolytes. 1.8. Hydrolysis of salts. Ionic product of water. Hydrogen value (pH) of the solution. 1.9. Redox reactions.
2. Мещеряков Н.В. Цепочки по химии элементов. М.: ООО "Луч", 2021. 68 с. URL:https://vk.com/doc379563091_671404865?hash=ycq21x65fU9GBj9JrO9oC8le3raug2VWnJanLtzyKJw&dl=kj7Fm5T77IQmFBqy1YBCjPvw5zwhSglW3RIHPtBep2k (open access)	1.10 Chemical properties of simple substances. 1.11. Chemical properties of the main classes of inorganic compounds.
3. Мещеряков Н.В., Старых С.А. Справочник олимпиадника. Химия элементов. М.: ООО «Луч», 2021. 188 с. URL:https://vk.com/doc379563091_671404866?hash=cDrknxkPNt601AVsTiRZyp2QzrcxFlIEux3PhM3Qfbk&dl=IZVNivsPlf9sAMzvZeN16TXX3MDqi1IyBKmgSkectZz (open access)	1.10 Chemical properties of simple substances. 1.11. Chemical properties of the main classes of inorganic compounds.
4. Тамм М.Е., Третьяков Ю.Д. Неорганическая химия. Том 1. М.: Издательский дом «Академия», 2004. 240с. URL://https://archive.org/details/Neorganich-himiya-Tretyakov-1/mode/2up (open access)	1.1. Atomic structure. 1.2. Periodic law and D.I. Mendeleev's periodic system periodic system of chemical elements. 1.3. Electronegativity. Valence. Oxidation state. 1.5. Types of chemical bonds, theory of hybridization of atomic orbitals.
5. Шевельков А.В., Дроздов А.А., Тамм М.Е. Неорганическая химия. Учебник. М.: Лаборатория знаний, 2021. 586с. URL://https://vk.com/doc257509691_656375317?hash=kNpQKqvaU3MTn8VmI7rKu8WJK9v9qnD39gGHhsZdKBk&dl=AHkqb2hfGditNjeCwnzUwOn8XOQtPMfb437X92Rv3eD (open access)	1.1. Atomic structure. 1.2. Periodic law and D.I. Mendeleev's periodic system periodic system of chemical elements. 1.3. Electronegativity. Valence. Oxidation state. 1.5. Types of chemical bonds, theory of hybridization of atomic orbitals. 1.10 Chemical properties of simple substances.

Organic Chemistry

Sources in English	Topics
<p>1. Graham Solomons T.W. Organic chemistry. Hoboken, NJ: John Wiley & Sons, 2016. 1293 p. URL://https://dl.iranchembook.ir/ebook/organic-chemistry-2808.pdf (open access)</p>	<p>2.1. Basic principles of organic chemistry: A.M.Butlerov's theory of chemical structure. Classification and nomenclature of organic compounds. 2.2. Saturated hydrocarbons: Nomenclature and isomerism. Reactions of free radical substitution, oxidation, cracking. Methods of obtaining. 2.3 Unsaturated hydrocarbons: Homologous series of alkenes and alkynes and their nomenclature. Chemical properties (electrophilic addition reactions, oxidation reactions). Methods of obtaining. 2.5. Oxygen-containing organic compounds: Classification, nomenclature and isomerism of alcohols, aldehydes, carboxylic acids. The most important chemical properties of alcohols, aldehydes, carboxylic acids. Methods of obtaining.</p>
<p>2. McMurry J. Fundamentals of organic chemistry. Belmont: Cengage Learning, 2011. 677 p. URL://https://tech.chemistrydocs.com/Books/Organic/Fundamentals-of-Organic-Chemistry-by-John-McMurry-7th-Edition.pdf (open access)</p>	<p>2.1. Basic principles of organic chemistry: A.M.Butlerov's theory of chemical structure. Classification and nomenclature of organic compounds. 2.4. Aromatic hydrocarbons: Classification, nomenclature and isomerism of arenes. Chemical properties: electrophilic substitution reactions, reduction. Orienting effect of substituents on the benzene ring. 2.5. Oxygen-containing organic compounds: Classification, nomenclature and isomerism of alcohols, aldehydes, carboxylic acids. The most important chemical properties of alcohols, aldehydes, carboxylic acids. Methods of obtaining.</p>
<p>3. Winter A. Organic Chemistry I For Dummies. Hoboken, J: John Wiley & Sons, 2005. URL://https://www.softouch.on.ca/kb/data/Organic%20Chemistry%20I%20For%20Dummies.pdf (open access)</p>	<p>2.1. Basic principles of organic chemistry: A.M.Butlerov's theory of chemical structure. Classification and nomenclature of organic compounds. 2.2. Saturated hydrocarbons: Nomenclature and isomerism. Reactions of free radical substitution, oxidation, cracking. Methods of obtaining. 2.3 Unsaturated hydrocarbons: Homologous series of alkenes and alkynes and their nomenclature. Chemical properties (electrophilic addition reactions, oxidation reactions). Methods of obtaining.</p>

Sources in Russian	Topics
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<p>1. Габриэлян О.С. Химия. 10 Класс. Базовый уровень. М.: Дрофа, 2007. 191 с. URL://https://p03601.edu35.ru/attachments/article/93/Химия.%2010%20класс.%20Базовый%20уровень_Габриэлян%20О.С_2007%20-192с.pdf (open access)</p>	<p>2.3. Aromatic hydrocarbons: Classification, nomenclature and isomerism of arenes. Chemical properties: electrophilic substitution reactions, reduction. Orienting effect of substituents on the benzene ring. 2.4. Oxygen-containing organic compounds: Classification, nomenclature and isomerism of alcohols, aldehydes, carboxylic acids. The most important chemical properties of alcohols, aldehydes, carboxylic acids. Methods of obtaining.</p>
<p>2. Карцова А.А., Лёвкин А.Н. Химия 10 Класс, профильный уровень. М.: «Вентана-Граф», 2011. 431 с. chrome-extension://efaidnbnmnibpcajpcglclefindmka/j/https://chemistryonline.ru/media/10%D0%BA%D0%BB.%20%D0%BF%D1%80%D0%BE%D1%84%D0%B8%D0%BB%D1%8C%20%D0%9A%D0%B0%D1%80%D1%86%D0%BE%D0%B2%D0%B0,%20%D0%9B%D1%91%D0%B2%D0%BA%D0%B8%D0%BD.PDF (open access)</p>	<p>2.1. Basic principles of organic chemistry: А.М. Butlerov's theory of chemical structure. Classification and nomenclature of organic compounds. 2.3. Aromatic hydrocarbons: Classification, nomenclature and isomerism of arenes. Chemical properties: electrophilic substitution reactions, reduction. Orienting effect of substituents on the benzene ring.</p>
<p>3. Рудзитис Г.Е. Химия, органическая химия 10 класс, базовый уровень. М.: Просвещение, 2012. 192 с. URL://https://kstu.kg/fileadmin/user_upload/khimija.pdf (open access)</p>	<p>2.1. Basic principles of organic chemistry: А.М. Butlerov's theory of chemical structure. Classification and nomenclature of organic compounds. 2.2. Saturated hydrocarbons: Nomenclature and isomerism. Reactions of free radical substitution, oxidation, cracking. Methods of obtaining. 2.2 Unsaturated hydrocarbons: Homologous series of alkenes and alkynes and their nomenclature. Chemical properties (electrophilic addition reactions, oxidation reactions). Methods of obtaining.</p>

Physical chemistry

Sources in English	Topics
<p>1. Burrows A., Holman J., Lancaster S., Overton T., Parsons A., Pilling G., Price G. Chemistry³. Oxford university press. 2021. 1440 p. URL://https://global.oup.com/ukhe/product/chemistry-9780198829980?cc=ru&lang=en (limited access)</p>	<p>3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes). 3.2. Reversible and irreversible chemical reactions. Chemical balance. Factors influencing the state of chemical equilibrium. Le Chatelier's principle. 3.3. Thermochemistry, Hess's Law. 3.4. Solutions. Methods of expressing the concentration of solutions.</p>

	<p>3.5. Electrochemistry.</p> <p>3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.</p>
<p>2. Chang R. General chemistry: the essential concepts. 5th ed. NY: McGraw-Hill, 2008. 836 p.</p> <p>URL:// https://chemistry.com.pk/books/chang-general-chemistry/ (open access)</p>	<p>3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes).</p> <p>3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.</p>
<p>3. Ebbing D.D. Gammon S. D. General Chemistry. U.S.A.: Houghton mifflin company, 2016, 864 p.</p> <p>https://zlib.pub/book/general-chemistry-686600i11qn0 (open access)</p>	<p>3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes).</p> <p>3.2. Reversible and irreversible chemical reactions. Chemical balance. Factors influencing the state of chemical equilibrium. Le Chatelier's principle.</p> <p>3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.</p>
<p>4. Chang R. General chemistry: the essential concepts. 5th ed. NY: McGraw-Hill, 2008. 836 p.</p> <p>URL:// https://chemistry.com.pk/books/chang-general-chemistry/ (open access)</p>	<p>3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes).</p> <p>3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.</p>
<p>5. Solovyeva G.V. General Chemistry. Basic level. Ekaterinburg. Ural University Publishing House, 2017. — 182 p.</p> <p>URL:// http://elar.urfu.ru/handle/10995/46981 (open access)</p>	<p>3.4. Solutions. Methods of expressing the concentration of solutions.</p> <p>3.5. Electrochemistry.</p> <p>3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.</p>

Sources in Russian	Topics
<p>1. Ахметов Н.С. Общая и неорганическая химия. Санкт-Петербург: Лань, 2018. — 744 с.</p>	<p>3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes).</p>

<p>https://publ.lib.ru/ARCHIVES/A/AHMETOV_Nail'_Sibgatovich_(himik)/%C0%F5%EC%E5%F2%EE%E2%20%CD.%D1.%20%CE%E1%F9%E0%FF%20%E8%20%ED%E5%EE%F0%E3%E0%ED%E8%F7%E5%F1%EAE0%FF%20%F5%E8%EC%E8%FF.(2023).pdf (open access)</p>	<p>3.2. Reversible and irreversible chemical reactions. Chemical balance. Factors influencing the state of chemical equilibrium. Le Chatelier's principle. 3.3. Thermochemistry, Hess's Law. 3.4. Solutions. Methods of expressing the concentration of solutions. 3.5. Electrochemistry. 3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.</p>
<p>2. Габриэлян О.С., Лысова Г.Г. Химия. 11 класс. Углубленный уровень. М: Просвещение, 2022. 432 с. URL:// https://prosv.ru/product/himiya-11-klass-uglublennii-uroven-elektronnaya-forma-uchebnogo-posobiya02/ (limited access)</p>	<p>3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes). 3.2. Reversible and irreversible chemical reactions. Chemical balance. Factors influencing the state of chemical equilibrium. Le Chatelier's principle. 3.3. Thermochemistry, Hess's Law. 3.4. Solutions. Methods of expressing the concentration of solutions. 3.5. Electrochemistry. 3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.</p>
<p>3. Еремин. В. В. Теоретическая и математическая химия для школьников. – М.: МЦНМО, 2018. 640 с. URL://https://vk.com/wall-70921366_44834 (open access)</p>	<p>3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes). 3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.</p>
<p>о4. Кузнецова Н.Е., Литвинова Т.Н., Левкин А.Н. Химия: 11 класс: углубленный уровень. М.: Вентана-Граф, 2018. 432 с. https://go.11klasov.net/15990-himija-11-klass-uglublennyj-uroven-uchebnik-kuznecova-ne-litvinova-tn-levkin-an.html (open access)</p>	<p>3.1. The first law of thermodynamics and its application (internal energy, enthalpy, heat and work, equilibrium and nonequilibrium processes). 3.2. Reversible and irreversible chemical reactions. Chemical balance. Factors influencing the state of chemical equilibrium. Le Chatelier's principle. 3.3. Thermochemistry, Hess's Law. 3.4. Solutions. Methods of expressing the concentration of solutions. 3.5. Electrochemistry.</p>

	3.6. Chemical kinetics and catalysis: the effect of concentration and temperature on the reaction rate, the Arrhenius equation, activation energy, methods for its determination.
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Analytical chemistry

Sources in English	Topics
1. Greenwood N.N., Earnshaw A. Chemistry of elements. Oxford: Elsevier, 1998. 1376 p. URL://http://lib.yzu.am/disciplines_bk/931545868d143aa17a18c4ad33a7ea3e.pdf (open access)	4.2. The most important chemical properties of compounds of s-elements (Na, K, Mg, Ca, Sr, Ba). 4.3. The most important chemical properties of compounds of p-elements (Al, Si, P, S, Pb, N, Cl). 4.4. The most important chemical properties of d-element compounds (Cr, Mn, Fe, Cu, Zn, Ni).
3. Vogel A.I., Svehla G. Textbook of Macro and Semimicro Qualitative Inorganic Analysis. Michigan: Longman Scientific & Technical, 1987. 310 p. URL://https://kresnadipayana.wordpress.com/wp-content/uploads/2018/10/macro-and-semimicro-qualitative-inorganic-analysis-5ed-vogel.pdf (open access)	4.1. Theoretical foundations of analytical chemistry: Balancing equations of chemical reactions and calculations based on them. Methods for identifying ions in solution (formation of precipitates, gases or colored compounds). Conditions for dissolution and precipitation. Methods for determining the equivalence point in titrimetric methods of analysis. 4.5. Qualitative analysis of solids and solutions: Methods for transferring solids into solution. Classification of ions by analytical groups. 4.6. Quantitative analysis: Gravimetry, titrimetry and its types.
3. Skoog D.A., West D.M., Holler J. Fundamentals of Analytical Chemistry, Ninth edition. Belmont: Cengage Learning, 2013. 1072 p. https://tech.chemistrydocs.com/Books/Analytical/Fundamentals-of-Analytical-Chemistry-by-Douglas-A.-Skoog-9th-Ed.pdf (open access)	4.1. Theoretical foundations of analytical chemistry: Balancing equations of chemical reactions and calculations based on them. Methods for identifying ions in solution (formation of precipitates, gases or colored compounds). Conditions for dissolution and precipitation. 4.5. Qualitative analysis of solids and solutions: Methods for transferring solids into solution. Classification of ions by analytical groups.

Sources in Russian	Topic
1. Гладышева И.В. Химия элементов: учебное пособие. Тамбов: Изд-во ФГБОУ ВПО «ТГТУ», 2013. 100 с. URL://https://www.tstu.ru/book/elib/pdf/2013/gladysheva-a.pdf	4.2. The most important chemical properties of compounds of s-elements (Na, K, Mg, Ca, Sr, Ba).

(open access)	4.3. The most important chemical properties of compounds of p-elements (Al, Si, P, S, Pb, N, Cl). 4.4. The most important chemical properties of d-element compounds (Cr, Mn, Fe, Cu, Zn, Ni).
2. Дорохова Е.Н., Прохорова Г.В. Задачи и вопросы по аналитической химии. М.: Мир, 2001. 267 с. URL://https://chembaby.ru/wp-content/uploads/2015/09/Analiticheskaya_khimiya_zadachi_Dorokhova_Prokhorov.pdf (open access)	4.1. Theoretical foundations of analytical chemistry: Balancing equations of chemical reactions and calculations based on them. Methods for identifying ions in solution (formation of precipitates, gases or colored compounds). Conditions for dissolution and precipitation. Methods for determining the equivalence point in titrimetric methods of analysis.
3. Лебедева М.И. Аналитическая химия: учебное пособие. Тамбов: Изд-во Тамб. Гос. Тех. Ун-та, 2008. 160 с. URL://https://www.tstu.ru/book/elib/pdf/2008/lebed_t.pdf (open access)	4.5. Qualitative analysis of solids and solutions: Methods for transferring solids into solution. Classification of ions by analytical groups. 4.6. Quantitative analysis: Gravimetry, titrimetry and its types.

Crystallography

Sources in English	Corresponding topic
1. Malgrange C., Ricolleau C., Schlenker M. Symmetry and Physical Properties of Crystals, Springer, 2011. 536p URL:https://reallib.org/reader?file=2243578&pg=531 (open access)	5.1. Crystalline substance and its properties. The concept of symmetry. 5.2. Crystal symmetry classes. Categories and syngony. 5.3. Types of Bravais lattices. 5.4. Types of chemical bonds in crystals.
2. Sanat K. Chatterjee Crystallography and the World of Symmetry, Springer-Verlag Berlin Heidelberg, 2008. 156 p URL:https://users.encs.concordia.ca/~mmedraj/TMG-Library/books/Crystallography_and_the_World_of_Symmetry.pdf (open access)	5.1. Crystalline substance and its properties. The concept of symmetry. 5.2. Crystal symmetry classes. Categories and syngony.
Sands D.T. Introduction to Crystallography. Dover publication, inc. New York. 1993. 179 p. https://www.geokniga.org/bookfiles/geokniga-introduction-crystallography.pdf (open access)	5.1. Crystalline substance and its properties. The concept of symmetry. 5.2. Crystal symmetry classes. Categories and syngony. 5.3. Types of Bravais lattices. 5.4. Types of chemical bonds in crystals.

Sources in Russian	Topic
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<p>1. Бараз В.Р., Левченко В.П., Повзнер А.А. Строение и физические свойства кристаллов: учебное пособие / В.Р. Бараз, В.П. Левченко, А.А. Повзнер. Екатеринбург: УГТУУПИ, 2009. 164 с. URL: /https://kf-info.urfu.ru/fileadmin/user_upload/site_62_6389/pdf/crystals.pdf (open access)</p>	<p>5.1. Crystalline substance and its properties. The concept of symmetry. 5.2. Crystal symmetry classes. Categories and syngony. 5.3. Types of Bravais lattices.</p>
<p>2. Еремин Н.Н., Еремина Т.А. Занимательная кристаллография. МЦНМО, 2014. 148 с. URL:https://vk.com/doc415041562_572598938?hash=Zta5HrBEHNUjxpVVTzS8XusPkjeK7VimZ80G6OkzwN4&dl=dQ8NddTBrFXuRzgHXytTVuQsUmqCsAe84epXtHqToYX (open access)</p>	<p>5.1. Crystalline substance and its properties. The concept of symmetry. 5.2. Crystal symmetry classes. Categories and syngony. 5.3. Types of Bravais lattices.</p>
<p>3. Ушакова Е.В. Введение в физику твердого тела: конспект лекций. Учебное пособие. СПб: Университет ИТМО, 2015. 97 с. URL: /https://books.ifmo.ru/file/pdf/1834.pdf (open access)</p>	<p>5.4. Types of chemical bonds in crystals.</p>

Testing in materials sciences

Sources in English	Topic
<p>1. Robert J. Young, Peter A. Lovell Introduction to Polymers, Third Edition CRC Press, 2011: 688 p. URL:/https://books.google.ru/books?id=ImQg2MK8NtkC&printsec=frontcover&redir_esc=y#v=onepage&q&f=false (open access)</p>	<p>6.1. Classification, nomenclature and hierarchy of polymers and composites based on them. 6.2. Methods for studying the structure and chemical composition of polymers and composites based on them (optical microscopy, atomic force microscopy, scanning electron microscopy, infrared spectroscopy).</p>
<p>2. Engineering Materials https://gitam.ac.in/wp-content/uploads/2024/02/ENGINEERING-MATERIALS.pdf</p>	<p>6.3. Methods for studying the physical and mechanical properties of materials (determination of tensile strength, determination of compressive strength, determination of double-support bending strength, determination of impact strength (viscosity), determination of impact strength on two supports (according to Charpy), determination of hardness by indentation of a ball (according to Brinell), determination of heat resistance). 6.4. Methods for studying the operational and special properties of polymers and composites based on them (determination of wear resistance, determination of</p>

	biostability, determination of light resistance, determination of resistance to liquid aggressive media, determination of abrasion resistance of coatings, wetting of polymers).
<p>3. Meyers M.A., Chawla K.K. Mechanical Behavior of Materials. Cambridge University Press. 2009. 882 p.</p> <p>https://ceimusb.wordpress.com/wp-content/uploads/2015/04/mechanicalbehaviormeyers.pdf (open access)</p>	<p>6.3. Methods for studying the physical and mechanical properties of materials (determination of tensile strength, determination of compressive strength, determination of double-support bending strength, determination of impact strength (viscosity), determination of impact strength on two supports (according to Charpy), determination of hardness by indentation of a ball (according to Brinell), determination of heat resistance).</p> <p>6.4. Methods for studying the operational and special properties of polymers and composites based on them (determination of wear resistance, determination of biostability, determination of light resistance, determination of resistance to liquid aggressive media, determination of abrasion resistance of coatings, wetting of polymers).</p> <p>6.5. Methods for processing experimental data (measurement errors and their classification; rules for processing the results of direct and indirect measurements; registration of measurement results).</p>
<p>4. Materials Science and Technology Ed. Hutagalung S.D. InTech. 2012. 336 p.</p> <p>http://www.issp.ac.ru/ebooks/books/open/Materials_Science_and_Technology.pdf (open access)</p>	<p>6.1. Classification, nomenclature and hierarchy of polymers and composites based on them.</p> <p>6.2. Methods for studying the structure and chemical composition of polymers and composites based on them (optical microscopy, atomic force microscopy, scanning electron microscopy, infrared spectroscopy).</p> <p>6.3. Methods for studying the physical and mechanical properties of materials (determination of tensile strength, determination of compressive strength, determination of double-support bending strength, determination of impact strength (viscosity), determination of impact strength on two supports (according to Charpy), determination of hardness by indentation of a ball (according to Brinell), determination of heat resistance).</p>

Sources in Russian	Topic
<p>1. Атомно-силовая микроскопия: учеб. пособие / С.Д. Карпухин, Ю.А. Быков. - М.: Изд-во МГТУ им. Н.Э. Баумана, 2012. – 38 с. URL:http://lab.bmstu.ru/students/MIM/ASM.pdf (open access)</p>	<p>6.2. Methods for studying the structure and chemical composition of polymers and composites based on them (optical microscopy, atomic force microscopy, scanning electron microscopy, infrared spectroscopy).</p>
<p>2. Зуев В.В., Успенская М.В., Олехнович А.О. Физика и химия полимеров. Учеб. Пособие. – СПб.: СПбГУ ИТМО, 2010. – 45 с. URL:/https://books.ifmo.ru/file/pdf/693.pdf (open access)</p>	<p>6.1. Classification, nomenclature and hierarchy of polymers and composites based on them.</p>
<p>3. Митин И.В., Русаков В. С..Анализ в обработке экспериментальных данных – М.: Физический Факультет МГУ. – 44 с. ISBN 5-8279-0022-2 URL:/https://portal.tpu.ru/SHARED/s/SHAMSHUT/study/labs/Tab1/I V Mitin V S Rusa kov.pdf (open access)</p>	<p>6.5. Methods for processing experimental data (measurement errors and their classification; rules for processing the results of direct and indirect measurements; registration of measurement results).</p>
<p>4. Мухин, Н. М. Определение реологических и физико-механических свойств полимерных материалов Екатеринбург: УГЛТУ, 2011. - 32 с. URL:/https://core.ac.uk/download/pdf/42046265.pdf (open access)</p>	<p>6.3. Methods for studying the physical and mechanical properties of materials (determination of tensile strength, determination of compressive strength, determination of double-support bending strength, determination of impact strength (viscosity), determination of impact strength on two supports (according to Charpy), determination of hardness by indentation of a ball (according to Brinell) , determination of heat resistance).</p>
<p>5. Ситникова, В. Е., Практикум по колебательной спектроскопии: Учебное пособие / Т.Н. Носенко, В.Е. Ситникова, И.Е. Стрельникова, М.И. Фокина– СПб: Университет ИТМО, 2021. – 173 с. URL:/https://books.ifmo.ru/file/pdf/2735.pdf (open access)</p>	<p>6.2. Methods for studying the structure and chemical composition of polymers and composites based on them (optical microscopy, atomic force microscopy, scanning electron microscopy, infrared spectroscopy).</p>
<p>6. Тагер А.А. Физико-химия полимеров. Издание 4-е, переработанное и дополненное. М.: Научный мир, 2007. 576 с. URL: https://www.ftorpolymer.ru/docs/Fiziko-khimia_polimerov_A_A_Tager.pdf (open access)</p>	<p>6.1. Classification, nomenclature and hierarchy of polymers and composites based on them.</p>
<p>7. Электронная микроскопия: учеб. Пособие / А. И. Власов, К. А. Ел-суков, И.</p>	<p>6.2. Methods for studying the structure and chemical composition of polymers and composites based on them (optical</p>

<p>A. Косолапов. – М.: Изд-во МГТУ им. Н. Э. Баумана, 2011. 168 с URL: /https://ftfsite.ru/wp-content/files/Kniga_11_Elektronnaya_mikroskopiya.pdf (open access)</p>	<p>microscopy, atomic force microscopy, scanning electron microscopy, infrared spectroscopy).</p>
<p>8. Чухланов, В. Ю. Современные методы исследования эксплуатационных свойств полимерных материалов : учеб. пособие к лаб. и практ. занятиям / В. Ю. Чухланов, Е. В. Ермолаева, Л. А. Чиждова ; Владим. гос. ун-т им. А. Г. и Н. Г. Столетовых. – Владимир: Изд-во ВлГУ, 2019. – 104 с. https://dspace.www1.vlsu.ru/bitstream/123456789/7969/1/01853.pdf (open access)</p>	<p>6.4. Methods for studying the operational and special properties of polymers and composites based on them (determination of wear resistance, determination of biostability, determination of light resistance, determination of resistance to liquid aggressive media, determination of abrasion resistance of coatings, wetting of polymers).</p>

Metallurgy

Sources in English	Topic
<p>1. Fundamentals of Metallurgy. Ed. Seetharaman. Woodhead Publishing Limited, 205. 589 p. https://steelcast.ru/f/fundamentals_of_metallurgy.pdf (open access)</p>	<p>7.1. Physical metallurgy. 7.2. Metal production and processing. 7.3. Corrosion and protection of metals.</p>
<p>2. Callister W.D., Rethwisch D.G. MATERIALS SCIENCE and ENGINEERING, John Wiley & Sons, 2014. 990 p. https://anupturnedworld.wordpress.com/wp-content/uploads/2016/06/callister-materials-science-and-engineering.pdf (open access)</p>	<p>7.1. Physical metallurgy. 7.2. Metal production and processing. 7.3. Corrosion and protection of metals.</p>
<p>3. Abbaschian R., Abbaschian L. Reed-Hill R.E. Physical metallurgy principal, Cengage learning, 2009. 769 p. https://sku.ac.ir/Datafiles/BookLibrary/46/Physical%20Metallurgy%20Principles%20(2009).pdf (open access)</p>	<p>7.1. Physical metallurgy. 7.2. Metal production and processing. 7.3. Corrosion and protection of metals.</p>

Sources in Russian	Topic
<p>1. Гуляев А.П. Металловедение. М.: Металлургия, 1986. 544 с.. URL://https://spb.bvb-alyans.ru/media/other/gulyaev_a_p_metallovedenie.pdf (open access)</p>	<p>7.1. Physical metallurgy. 7.2. Metal production and processing. 7.3. Corrosion and protection of metals.</p>

<p>2. Солнцев Ю.П., Пряхин Е.И. Материаловедение. СПб: Химиздат, 2007. 784 с. URL:// https://777russia.ru/book/uploads/%D0%9C%D0%95%D0%A2%D0%90%D0%9B%D0%9B%D0%9E%D0%92%D0%95%D0%94%D0%95%D0%9D%D0%98%D0%95/%D0%A1%D0%BE%D0%BB%D0%BD%D1%86%D0%B5%D0%B2%20%D0%AE.%20%D0%9F.%20-%20%D0%9C%D0%B0%D1%82%D0%B5%D1%80%D0%B8%D0%B0%D0%BB%D0%BE%D0%B2%D0%B5%D0%B4%D0%B5%D0%BD%D0%B8%D0%B5%20-%202007.pdf (open access)</p>	<p>7.1. Physical metallurgy. 7.2. Metal production and processing. 7.3. Corrosion and protection of metals.</p>
<p>3. Основы материаловедения (металлообработка). Учебник. Под ред. Заплатина В.Н. М.: Издательский центр «Академия», 2017. 272 с. https://urpc.ru/student/pechatnie_izdania/005_708212084_Zaplatin.pdf (open access)</p>	<p>7.1. Physical metallurgy. 7.2. Metal production and processing.</p>

4.2. Recommended Online Courses

Inorganic and nuclear chemistry

Online-courses in English	Link	Summary
1. General Inorganic Chemistry	URL://https://www.alphaacademy.org/course/general-inorganic-chemistry/	The course covers the main topics of General Chemistry
2. General Chemistry I Online Course	URL://https://und.edu/academics/online/enroll-anytime/chem121.html	This course covers the elementary principles and theories of chemistry: matter, measurement, atoms, ions, molecules, reactions, chemical calculations, thermochemistry, communication, molecular geometry, periodicity, and gases.
3. General chemistry	URL://https://ecampus.oregonstate.edu/online-degrees/undergraduate/online-general-chemistry/	This general chemistry course gives the introduction into the fundamentals of chemistry. It helps to complete lab work with hands-on projects at home

		that allow to practice or repeat experiments.
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Online-courses in Russian	Link	Summary
1. Неорганическая химия	Бесплатный онлайн-курс «Неорганическая химия» (lektorium.tv) URL://https://www.lektorium.tv/inorganicchemistry	The course covers the properties of the basic chemical elements of the Periodic Table. When considering chemical properties, the concept of their division into three main groups is supported: acid-base properties, redox transformations and complexation reactions
2. Общая и неорганическая химия	URL://https://openedu.ru/course/msu/GENERALINORGANICCHEMISTRY/	This course, drawing on extensive experience in teaching "General and Inorganic Chemistry" at Moscow State University, offers a comprehensive approach to the subject. It not only covers traditional topics typically found in general chemistry courses but also integrates them into a balanced framework focusing on the chemistry of elements. The online course explores key areas of general chemistry, including the fundamentals of chemical kinetics and thermodynamics, equilibrium in electrolyte solutions, redox processes, atomic and molecular structure theories, and trends in the properties of elements across different groups.
3. Неорганическая химия: введение в химию элементов	URL://https://facultetus.ru/courses/275	The course is devoted to the current state of the theory of periodicity - the development of D.I. Mendeleev's Periodic Law from its discovery to the present day. Numerous examples reveal patterns of changes in the properties of s, p, d, f elements and chemical

		compounds, and demonstrate the possibility of predicting the most important characteristics of substances. Modern directions of development of inorganic chemistry at St. Petersburg State University are presented.
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Organic chemistry

Online-courses in English	Link	Summary
1. Organic chemistry (EDX)	URL://https://www.edx.org/learn/organic-chemistry	The Organic Chemistry course focuses on the study of organic compounds, which include one or more carbon atoms. It covers fundamental topics such as various types of organic reactions, the structures of organic molecules, and classes of hydrocarbons including alkanes, cycloalkanes, alkenes, and alkynes. Additionally, the course examines biomolecules like amino acids, peptides, proteins, nucleotides, and nucleic acids.
2. Organic chemistry (Khan Academy)	URL://https://www.khanacademy.org/science/organic-chemistry	This course introduces the reactions used by chemists to synthesize carbon-based structures and the analytical methods employed to describe them. It outlines the molecular-level processes involved in these reactions, focusing on reaction mechanisms to provide a comprehensive understanding of how they occur.
3. Foundations of organic chemistry (Classcentral)	URL://https://www.classcentral.com/course/the-great-courses-plus-foundations-of-organic-chemistry-131481	This course provides the outlines of organic chemistry, one of the most challenging areas of science.

Online-courses in Russian	Link	Summary
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1. Органическа я химия (Stepik)	<a href="https://stepik.org/course/70826/pr
omo">URL://https://stepik.org/course/70826/pr omo	The organic chemistry course is designed to systematize knowledge about the diversity of organic substances. Contains theoretical information about the main classes of organic compounds.
2. Органическа я химия (Лекториум)	URL://https://www.lektorium.tv/organic-chemistry	This course introduces advanced topics in organic chemistry, focusing on less commonly covered areas. It provides a thorough understanding of various reaction mechanisms, including free radical substitution in alkanes, electrophilic addition in alkenes, electrophilic substitution in aromatic compounds, and nucleophilic substitution mechanisms (SN1 and SN2) in alcohols and haloalkanes.
3. Органическа я химия	URL://https://stepenin.ru/organic	A short video course on organic chemistry for schoolchildren.

Physical chemistry

Online-courses in English	Link	Summary
1. Advanced Chemistry	https://www.coursera.org/learn/advanced-chemistry	The course covers selected topics studied in high school (kinetics, chemical equilibrium, thermodynamics).
2. Introduction to Physical Chemistry	https://www.coursera.org/learn/physical-chemistry	The course covers key concepts of the main topics in the course of physical chemistry: thermodynamics, kinetics.
3. General Chemistry: Development and Application of Concepts	https://www.coursera.org/learn/general-chemistry#recommendations	The course covers phase transitions and equilibria, gas laws, kinetic theory of gases, chemical kinetics, chemical thermodynamics, chemical equilibrium.

Online-courses in Russian	Link	Summary
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1. Химия. Часть 1	https://openedu.ru/course/mephi/mephi_chemistry/	The course contains information on chemical thermodynamics, the state of aggregation of substances, and solutions. chemical kinetics, and catalysis.
2. Химия: Часть 2	https://openedu.ru/course/mephi/mephi_chemistry2/	The course contains information on electrochemistry. The material is presented mainly in English with Russian subtitles.
3. Онлайн-школа абитуриента ТГУ: Химия	https://ido.skills.tsu.ru/course/view.php?id=127	The course focuses on basic chemistry modules. The course is in Russian.

Analytical chemistry

Online-courses in English	Link	Summary
1. Basic analytical chemistry (EDX)	URL://https://www.edx.org/learn/chemistry/the-university-of-tokyo-basic-analytical-chemistry	This course introduces the principles of analytical chemistry and shows how these principles are applied in chemistry and related disciplines, especially the life sciences, environmental sciences, and geochemistry.
2. Analytical chemistry (Alison)	URL://https://alison.com/tag/analytical-chemistry	These free online analytical chemistry courses teaches how to identify and quantify substances. Analytical chemists use a variety of tools and techniques to separate, identify, quantify, and study substances using a variety of classical, wet chemistry, and modern instrumental techniques.
3. Inorganic chemistry (Alison)	URL://https://alison.com/tag/inorganic-chemistry	Inorganic chemistry deals with the study of inorganic non-carbon compounds. Thus, inorganic chemistry studies the properties, characteristics and reactions of elements, metals, alloys, salts, complexes, acids and any other non-carbon substances.

Online-courses in Russian	Link	Summary
1. Аналитическая химия. (Teach-in.ru)	https://teach-in.ru/course/analitchem	The lecture material is devoted to the consideration of the theoretical foundations of chemical analysis of substances, based on the fundamental laws of chemistry and physics. The main theoretical provisions, laws of chemical equilibria (acid-base, oxidation-reduction, complexation and precipitation) and classical chemical methods of analysis (titrimetry and gravimetry) are considered; the essence, characteristics and application of titrimetric and gravimetric methods of analysis are discussed. The general principles and basic methods of separation and concentration of substances are presented; the main methods of sampling and sample preparation are considered. Attention is paid to metrological aspects and objects of chemical analysis.
2. Аналитическая химия (HSE University)	URL://https://www.hse.ru/edu/courses/892124717	Analytical chemistry is the science of determining the chemical composition of substances and materials, i.e. on methods and means of chemical analysis. Chemical analysis is divided into types: elemental analysis, material analysis, molecular analysis, isotopic analysis and, in some cases, structural group analysis. A distinction is made between qualitative analysis (identification) and quantitative analysis.
3. Неорганическая химия: введение в химию элементов (Stepik)	URL://https://stepik.org/course/2542/промо	The course is devoted to the current state of the theory of periodicity - the development of D.I. Mendeleev's Periodic Law from its discovery to the present day. Numerous

		examples reveal patterns of changes in the properties of s, p, d, f elements and chemical compounds, and demonstrate the possibility of predicting the most important characteristics of substances.
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Crystallography

Online-courses in English	Link	Summary
1. The Fascination of Crystals and Symmetry	URL://https://iversity.org/en/courses/the-fascination-of-crystals-and-symmetry-2021	The course covers the basic building blocks of crystals, their symmetrical structure, and introduces free software for studying crystal structure. In this course we will provide you with a basic introduction to crystallography. The main attention is paid to the symmetry elements found in crystals. The arrangement of atoms within a crystal needs to be described in more detail than the overall shape of the crystal (morphology). We want to show you how symmetry is classified hierarchically. We want our students to have the opportunity to discover symmetry on their own.
2. Chemical Crystallography	URL://https://onlinecourses.nptel.ac.in/noc19_cy35/preview	The course covers the concepts and applications of the widely used experimental technique of X-ray crystallography. This could take students along the path of crystallographic symmetry to structure determination and refinement of crystal structures using X-ray diffraction. This course will be useful to any experimental organic or inorganic chemist.
3. Symmetry Operations, Types of Twinning, and Miller Indices of Crystal Planes - Mineralogy	URL://https://www.classcentral.com/classroom/youtube-symmetry-operations-types-of-twinning-miller-indices-of-crystal-planes-mineralogy-geo-girl-137414	This course covers mineralogy and crystallography with GEO GIRL's short online program. It tells about symmetry

		operations, twins in minerals, and Miller indices of planes.
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Online-courses in Russian	Link	Summary
1. Основы кристаллохимии	URL://https://www.lektorium.tv/crystalchemistry	The course presents the main sections of structural crystallography and crystal chemistry necessary for a modern chemist or physicist.
2. Физическая кристаллография	URL://https://www.my-mooc.com/ru/mooc/fizicheskaya-kristallografiya	The course covers the basics of crystallography, the theory of finite groups and theory of group representation, crystal symmetry, the influence of symmetry on the physical properties of crystals, main types of crystal structures, crystallography plastic deformation of mono- and polycrystals, methods descriptions of texture in polycrystals, crystallography phase transformations and interfaces.
3. Кристаллография. Часть 1	URL://https://teachin.ru/course/crystallography	This course lays the foundation for advanced studies in mineralogy, petrography, geochemistry, and related fields. It explores the crystalline structure of minerals, their physical properties, formation conditions, and behavior within the Earth's crust. Additionally, the course examines the potential uses of natural materials in the national economy, methods for mineral exploration, and the development of synthetic materials with specific physical properties. The course is aimed at training students in practical skills of working with crystals, mastering the techniques of competently describing the external form of a crystalline

		individual, which is necessary both for the correct interpretation of the results of independent scientific work and for understanding specialized literature.
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Characterization & testing

Online-courses in English	Link	Summary
1. Introduction to polymers	URL://https://www.open.edu/openlearn/science-maths-technology/chemistry/introduction-polymers/content-section-0?active-tab=content-tab	This course provides an introduction to materials science and engineering, with a focus on the mechanical properties of materials.
2. Polymers Mechanical properties	URL://https://www.youtube.com/watch?v=qUSCCGXXHpU	This is an online lecture “Mechanical properties of polymers” (University of Wyoming)
3. Polymers: Synthesis, Properties & Applications	URL://https://mitocw.ups.edu.ec/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/organic-materials/29-polymers-synthesis-properties-applications/	This course focuses on polymer synthesis, the relationship between polymer structure and properties, and the cultural significance of polymers.
4. Mechanical Properties Definitions {Texas A&M: Intro to Materials}	URL://https://www.youtube.com/watch?v=1UbO7UxvPBc	This course provides an introduction to materials science and engineering, with a focus on the mechanical properties of materials.

Online-courses in Russian	Link	Summary
1. Технология современных композиционных материалов с углеродными наполнителями / Technology of modern composite materials with carbon fillers	URL://https://openedu.ru/course/spbstu/MOCOMAT/	The course is aimed at gaining new knowledge about materials, including advanced polymers and composites based on them.
2. Передовые композиционные материалы: химия и применение	URL://https://stepik.org/course/107500	The course is devoted to the operational, thermal and other properties of materials and methods for their determination.

3. Методы анализа поверхности	URL://https://openedu.ru/course/mephi/mephi_msa/	The course covers the most widely used analysis methods in modern surface science.
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Metallurgy & metallurgical engineering

Online-courses in English	Link	Summary
1. Principles of Metallurgy	URL://https://www.aws.org/Certification-and-Education/Education/Principles-of-Metallurgy/	This course covers three key principles of metallurgy: the microscopic structures present in metals, the impact of microstructure and alloy composition on metal strength, and the role of composition, cold working, and heat treatment in modifying the microstructure to achieve desired mechanical properties.
2. What is a metal?	URL://https://www.classcentral.com/course/openlearn-science-maths-technology-chemistry-what-metal-95737	The course explores the basic characteristic properties of metals and their varied uses in our daily lives. Each metal has its own signature and you will conduct an online experiment to identify individual metals.
3. Diploma in Electrochemistry of Corrosion	URL://https://alison.com/course/diploma-in-electrochemistry-of-corrosion	This course covers the electrochemistry of corrosion and teaches about the processes that can cause corrosion, as well as the impact of different forms of corrosion and how to derive the important Nernst equation. It also teaches about the steps for constructing a Pourbaix diagram and be able to explain the relevance of the mixed potential theory.
4. The Basic Science of Metallurgy	URL://https://alison.com/course/the-basic-science-of-metallurgy	This course explains the fundamental concepts of metallurgy and its uses in modern society.

Online-courses in Russian	Link	Summary
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1. Введение в материаловедение	URL://https://openedu.ru/course/misis/MATSC1/?session=spring_2024	The course contains information about the main sections of materials science.
2. Основы физического материаловедения	URL://https://openedu.ru/course/mephi/mephi_ofm/	The course contains basic topics related to physical materials science.
3. Видеолекции онлайн-курса «Материаловедение в машиностроении»	URL://https://rutube.ru/plst/305313/	The course contains information about the main sections of materials science, including metallurgy.