

Syllabus for Mineral Science, GEO-220

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Office hours: Stop by any time, or by appointment

Textbook: Mineralogy and Optical Mineralogy, 2nd ed., Dyar et al. (free from me)

Month	Week	Date	Topic	Chapters*
January	1	4	Plane, line, and point symmetry operators, the 7 crystal systems, external symmetry, crystal forms Lab: External symmetry, block models	1, 4, 11
		6	The 32 crystal classes, unit cells, Miller indexes	
	2	11	Mineral properties Lab: Native elements, sulfides, arsenides, halides	2, 6, 12*, 23*
		13	Bravais lattices, 230 space groups: translation, screw axes, glides	
	3	18	X-ray diffraction: theory, instrumentation, crystallography, Braggs law Lab: X-ray diffraction	3, 15
		20	Chemical bonding, ionic model and coordination	
	4	25	Atomic substitutions, crystal chemistry Lab: Hydroxides, carbonates, sulfates, phosphates	7, 8, 9
		27	Crystal chemistry, element partitioning	
February	5	1	Becke lines, dispersion, isotropic minerals Lab: Microscopes, oil immersion, isotropic minerals	5, 10, 14
		3	Introduction to microscopes, immersion oils	
	6	8	Uniaxial minerals, optic figures Lab: Optical properties of uniaxial and biaxial minerals	16, 17
		10	Biaxial indicatrix and optic figures	
	7	15	Color in minerals Lab: Asbestos optics, nesosilicates, sorosilicates, cyclosilicates	18, 19
		17	Silicates: isolated, bow tie, and ring silicates	
	8	22	Twinning, exsolution, inversion Lab: Sheet silicates, work on mineral sets	20, 21, 22*
		24	Silicates: sheet silicates, sheet silicate model building	
March	9	1	Scanning electron microscopy, instrumentation and techniques Lab: SEM, imaging, and X-ray emission analysis	24
		3	Silicates: chain silicates	
	10	8	Silicates: framework silicates Lab: Inosilicates, tectosilicates, review	
		10	Finish up silicates, review	

*Chapters 12, 22, and 23 are for guidance and reference, and really not to be read thoroughly at one sitting. You must, however, be fluent in the concepts and operations, and must always read carefully the introductory sections and *all sections on minerals you are currently working with*. Chapter 13 is not part of this course, though it is the fundamental basis for understanding symmetry.

Purpose and scope of this course

This course is an introduction to the external form, external and internal symmetry, physical properties, chemical composition, crystal structure, crystal chemistry, and physics of minerals. We will commonly use a hands-on approach, and will examine mineral hand samples and several kinds of models. Equipment to probe subtler mineral properties include the polarizing microscope, Geiger counter, density measurement, UV lamp, X-ray diffraction, and scanning electron microscope.

We will not examine, in any detail, the reasons why minerals occur in certain environments or in particular associations. That subject is petrology, which will be taught in the spring. One might wonder what use there is for mineralogy in everyday life, or in various professional careers. Here are some examples:

- Mineralogy provides a fundamental tool for geologic field mapping, petrology, mineral exploration, and interpreting some geologic hazards.
- Crystal symmetry, physics, and chemistry are basic parts of a wide range of materials science applications, including the search for new superconductors, the behavior of composite materials like concrete and metal alloys, and the development of advanced ceramic materials for gas turbines.
- Mineralogical techniques, including x-ray diffraction, scanning electron microscopy, and polarized light microscopy are powerful tools for characterizing solid materials, including medicines, plastics, ceramics, metals, semiconductors, and identifying mineral hazards such as asbestos.
- Knowledge of mineralogy can help you better understand many aspects of water chemistry, because water chemistry is partly controlled by mineral dissolution, precipitation, and ion exchange reactions.
- Having mineral identification skills will help you to better see and understand things in the world around you, which will make your whole life more interesting.

The tools of mineralogy include many of the basic tools of engineering, materials science, forensics, and manufacturing. Mineralogy is therefore a broad field with many branches, with interesting and practical applications.

Evaluation of the final grades

All homework will be due one week after it is assigned. Your grade will be based on topics in the table below. The final exam will be held during exam week. There is no mid-term exam. Homework assignments are each worth 10 points. Late homework will lose 10% per day, so get everything in on time! The lab final is due at the time of the final exam.

50%	Homework
20%	Lab final exam (lasts most of the term)
30%	Final exam
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100%	Total

Literature resources

Check library listings under "minerals", "mineralogy", "optical mineralogy", "crystallography", and related terms. The library has many volumes of the Mineralogical Society of America *Reviews in Mineralogy* Series. This is a state-of-the-art review series on the chemistry, physics, and occurrence of minerals, mineral-related processes, thermodynamics, and solid solar system bodies. Also see the [AGU Elements magazine](#), which is free and covers geochemical and mineralogical topics in short, generally well-written articles. The top U.S. mineralogical journal in the U.S. is the [American Mineralogist](#), available to Union College license.

Extra help

For extra help see me. I am generally available and I can always make appointments. I can even schedule weekly or more frequent regular appointments to give extra help to individuals or small groups.

Learning outcomes

In this course you will learn many of the common tools of mineral science, the theories behind them, and you will use the tools on sample sets. You will examine, evaluate, and apply problem-solving techniques to evidence, data, and sample sets, and communicate clearly and correctly the results of such analysis.

The following is academic boilerplate, important though not specific to this course

Most of the following is verbatim from Union College documents. Preexisting disabilities, mental health problems, and serious illness should not be ignored or hidden. They can lead to serious difficulties in your academic career, and elsewhere in your life. These services are here for you to use as necessary. Do so. Academic misconduct is a somewhat different matter. Do not copy the work of others without attribution. In this course, you may talk to and work with your fellow students on any and all homework and projects, but what you turn in must be written or otherwise produced by you, including figures and tables. More details below.

Reading, class attendance, turning in work

All students are expected to attend all classes and labs. If attendance is impossible for some reason, materials will be made available on-line, so you will still be responsible for all work (readings, labs, tests), on which your grade will be based. All assignments, including labs, will be due Saturday noon the same week each lab takes place. *Can't turn it in by then? Get it in earlier!* If you have to miss a class, quiz, exam, or lab for some valid reason (e.g., you being quarantined), let [me](#) and the [Dean of Students](#) office know beforehand to make alternative arrangements. I can't make arrangements after the fact without a valid excuse through the [Dean of Students](#) office. Sorry folks, just following College policy.

This not a fast-paced or particularly difficult course, but it is a fast-paced 10-week term. Because of that, late work will generally not be accepted, except as recommended by Deans. Get work in on time!

Specifics for medical issues: If you have to or have missed or may miss a class, lab, or homework deadline because of illness, go to the Wicker Wellness Center, or send them the relevant medical documentation (fax to 518-388-6147, email to uhealthcenter@union.edu, web site: <https://www.union.edu/health-services>). The Wellness Center will make an evaluation. They may or may not send that information on to the Dean of Students, with your permission, but if you are sick you should certainly see someone. Wear your masks, etc., and try not to get sick.

Extra help

For extra help there is always me, of course. I will have office hours and I can make Zoom or in-person appointments (in-person will require masks etc.). I can even schedule weekly or more frequent regular appointments to give extra help to individuals or small groups. Geoscience majors may be hanging out on the 3rd floor of Olin, and are mostly harmless, and can also be quite helpful (masks etc. required, as usual).

Recommended on-line classes boilerplate

"If you are quarantined or isolated for COVID-19-related reasons, I will be notified by the Dean of Students Office that you may require flexibility with regard to your participation in this course. Your responsibility will be to contact me as soon as you are able so that we can discuss your needs. If you are not able to keep up with the course in real time, I will make arrangements to provide you with full course material missed from classes."

In addition, all materials will be available on Nexus or the class web site, and all Zoom classes and labs, if we have to do any, will be recorded and available. That means you can be away or out of touch for a while, and still turn in the work. Do so.

Learning or other disabilities

From the Union College Student Handbook: *"Students seeking reasonable accommodations should be aware that it is their responsibility to...request accommodations from the Director [of Student Support Services] in person with at least two (2) weeks notice of the accommodation needed."* Contact them directly:

[Accommodative Services Office](#), 388-8785, <mailto:shinebas@union.edu>. No accommodations can be provided without a letter or card from the [Accommodative Services Office](#). You talk the them, they will notify me. You should also talk to me, too, to make sure I am aware of (or remember) the issue so we can arrange things appropriately.

Academic misconduct

You will sometimes work in small groups, but *all work that you hand in must be your own!* No copying or otherwise duplicating lab reports or computer-generated figures. No giving or accepting access to old course materials. This and all other forms of plagiarism, cheating, destruction of resource materials, and other forms of academic dishonesty will be referred immediately to the [Dean of Studies](#), as per *Union College policy*.

We have an [Honor Code](#) at Union College. Here is the "[model statement](#)" that I have been asked to place right here in this very spot:

"Union College recognizes the need to create an environment of mutual trust as part of its educational mission. Responsible participation in an academic community requires respect for and acknowledgement of the thoughts and work of others, whether expressed in the present or in some distant time and place. Matriculation at the College is taken to signify implicit agreement with the Academic Honor Code, available at honorcode.union.edu. It is each student's responsibility to ensure that submitted work is his or her own and does not involve any form of academic misconduct. Students are expected to ask their course instructors for clarification regarding, but not limited to, collaboration, citations, and plagiarism. Ignorance is not an excuse for breaching academic integrity. Students are also required to affix the full Honor Code Affirmation, or the following shortened version, on each item of coursework submitted for grading: 'I affirm that I have carried out my academic endeavors with full academic honesty.'"

Signed

Whoever you are

Note that, if you forget to "...affix the full Honor Code Affirmation, or this shortened version, on each item of coursework submitted for grading: "I affirm that I have carried out my academic endeavors with full academic honesty.", I will assume that you meant to.