

GEL 4050 - Intro to Ign. & Metamorphic Petrology Syllabus

Spring 2017

Meeting: Sec.001 - 34977: T R 11:00 - 01:15pm Room: SI2012
 Professor: Uwe Richard Kackstaetter, Ph.d. (Dr. "K") Office: SI2025
 Office Hours: M, W 09:00-11:00am; T 2:00-3:30pm; Other times by appointment!
 Contact: E-mail: kackstae@msudenver.edu Phone: 303-556-3070 URL: <http://college.earthscienceeducation.net>

This syllabus may be modified at any time without prior notice.

Course Description

This course involves the study of the nature, composition, origin, and history of igneous and metamorphic rocks. Students will be introduced to the principles that govern the mineralogical and textural diagenesis of these systems and their unique mineral assemblages. Lab exercises in optical microscopy, geochemical data interpretation, graphical analysis and classification modalities are essential components. Prior working knowledge of polarized optical microscopy, mineralogy, and chemistry is prerequisite. Familiarity with programming simple electronic spreadsheet algorithms is highly recommended. A fieldtrip is required.

Prerequisites: GEL 1010, GEL3050, CHE1800

Highly Recommended: Basic algebra concepts as well as some trig

Required Materials

- Raymond, L.A. (2007). Petrology: The Study of Igneous, Sedimentary, and Metamorphic Rocks. 2nd edition, Illinois: Waveland Press, Inc.
- Field Notebook
- Raith, M.M., Raase, P. & Reinhardt, J., 2011, Guide to Thin Section Microscopy. Free Download from http://www.minsocam.org/msa/content/OpenAccess_publications/Thin_Section_Microscopy.pdf
- Thin Section Kit + previous tools from GEL1010 and GEL3050!
- Rock hammer & camera are a must!
- i-clicker (ABSOLUTE MUST! YOUR GRADE DEPENDS ON IT)

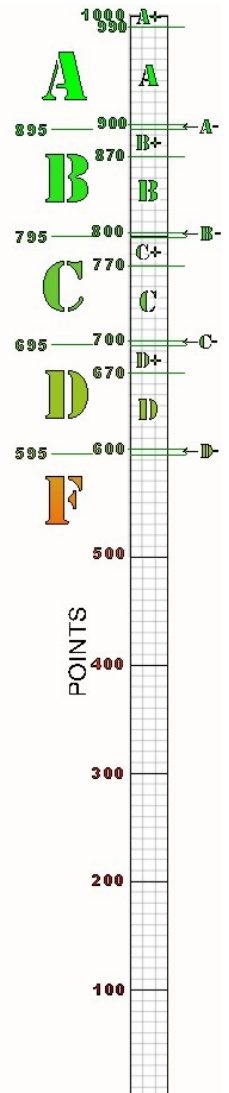
Specific (Measurable) Student Behavioral Learning Objectives

Upon completion of the course the student should be able to:

1. Calculate CIPW normative igneous mineralogies from geochemical data
2. Evaluate igneous rock formative processes from observed mineral assemblages
3. Compare Bowen's Reaction Series to observed minerals
4. Construct the mineralogy of igneous rocks using multi-phase solid solution diagrams
5. Correctly estimate igneous classifications from hand samples and optical microscopy
6. Differentiate between various minerals, both in igneous and metamorphic samples
7. Diagram the mineral diagenesis in appropriate metamorphic P/T systems
8. Assess pressure and temperature conditions of metamorphic formations from observed mineralogies

Major Topics & Subtopics

- Igneous Rocks
 - Igneous Mineralogy & Bowen's Reaction Series
 - Identifying Igneous Rocks - Macroscopic Samples
 - Igneous Rocks Thin Section Analysis (Polarized Light Microscope)
 - Whole Rock Geochemical Analysis
 1. CIPW Norm calculations
 - Evolution of Magmas / Minerals in Igneous Systems
- Metamorphic Rocks
 - Metamorphic Mineralogy
 - P/T Diagrams
 - Identifying Metamorphic Rocks – Macroscopic Samples
 - Metamorphic Rocks Thin Section Analysis (Polarized Light Microscope)
 - Metamorphic Rock Interpretation – Geobarometer & Geothermometer



Grading in GEL4050

	Max. Points	MY GRADE
Participation / i-clicker	100	Keep track of your grade! Color in Grade Graph to the right!
4 selected LAB assignments (50pts ea.)	200	
4 unannounced random quizzes (25pts ea.)	100	
Mineral ID precursor Exam HANDSAMPLE*	100	
Mineral ID precursor Exam OPTICAL*	(50 pts ea.)	
Igneous Rocks Comprehensive Module Exam	200	
Metamorphic Rocks Comprehensive Module Exam	(100 pts ea.)	
PETROLOGY PROJECT	300	
TOTAL	1000	

Note: NO comprehensive FINAL; *students who fail any of these two exams are encouraged to drop the course
 FINAL GRADE: A+ > 990 A = 900-990 A- = 895-899 B+ = 870-894 B = 800-869 B- = 795-799
 C+ = 770-794 C = 700-769 C- = 695-699 D+ = 670-694 D = 600-669 D- = 595-599
 F = ≤ 594 points

**WARNING! MINUS POINTS FOR LAB INFRACTIONS, ESPECIALLY CLEAN-UP VIOLATIONS!****FINAL GRADE POINT DEDUCTIONS: 1st Infraction: Warning! 2nd Infraction: -5pts of Final Grade****3rd Infraction: -10pts of Final Grade 4th Infraction: -15pts of Final Grade****5th Infraction: -20pts of Final Grade and revocation of Lab privileges****Note: Deductions are cumulative!!! Example: 4th Infraction = -15 + -10 (3rd Infr.) + -5 (2nd Infr.) = -30pts**

PARTICIPATION: You are EXPECTED to attend class & labs and PAY ATTENTION in both. Attendance & Student Responses will be tracked using the I-clicker interactive student response system. The timely purchase of the device is REQUIRED in order to earn full participation points (see point distribution below). **If you forget your clicker or do not have one (NOT recommended), you MUST sign a special roll in order to receive at least partial credit for attending class (Lowest score of the day minus 10%). Points can NOT be assigned retroactively !!!** Students can earn daily points toward their participation grade by responding CORRECTLY to i-clicker questions randomly presented during lectures / labs. I absolutely DESPISE students with less than 80% participation, whining about their grade at the end of the semester. (So, don't even try!). In regards to attendance & class materials: Any handout, any notes, any exam questions discussed will only be given IN CLASS. If you miss class, you are on your own. I do not keep extra copies and NO, I do not have or publish lecture notes for your convenience! (THIS NOT AN ONLINE CLASS!)

Point Distributions:

15 Week Course meeting	(a) twice per week: 3.3pts/day	(b) once per week: 6.6pts/day
10 Week Course meeting	(a) twice per week: 5pts/day	(b) once per week: 10pts/day
8 Week Course meeting	(a) twice per week: 6.25pts/day	(b) once per week: 12.5 pts/day

ABSENCES: Frankly, registering for this course is equivalent and as serious as you taking a job. I expect from you the same professional courtesies that you would extend toward your employer. As with any employer, you do NOT get paid for missed days, meaning, there are NO participation points awarded if you do not show up for class. Period! However, similarly to the real employment world, I will grant you "sick or leave days" worth a total of 10 participation points, which you may use at your discretion. As with most employment situations, you may "cash in" your remaining "sick or leave days" for extra credit at the end of the semester. Absences beyond these allotted points will never be awarded anything, no matter the reason, including but not limited to illness, work conflicts, car accidents, booked vacations, etc.

Exception: Jury-Duty: You must bring official proof of your actual court room duty validated by the court / judge! (No, the little card you get in the mail soliciting you for jury duty does NOT count!)

Note: Nothing in this policy shall require the instructor to reschedule classes, repeat lectures or other ungraded activities or provide ungraded individualized instruction solely for the benefit of students who are unable to attend regularly scheduled classes or activities.

TEST MAKE-UP: Only with a Doctor's note or Jury-Duty!

EXAMS: There are two precursor exams (100pts ea) covering mineral identification of common rock forming minerals in handsample and thinsection will be given during the first week of class. Students who fail any of these two exams are encouraged to drop the course. In addition, there two comprehensive module exams for igneous and metamorphic rocks respectively. These in-class exams consists of 5 essay questions. Each question is graded on a 20pt scale. You will lose points for uncertainties, errors, and/or incompleteness as well as spelling and grammar. If math is required, make sure units are present and your mathematical solution shows a step by step approach. Explain any symbols or shorthand that is used. You may use additional pages as needed. Make-up only possible with legitimate excuse in writing accompanied by official documentation.

QUIZZES: There are 4 unannounced random in class quizzes (25pts ea.). These short quizzes can NOT be made up unless you have a legitimate excuse in writing accompanied by official documentation.

PETROLOGY PROJECT & FIELDTRIP: There is an involved Petrology Project for this course using analytical procedures. This is about 1/3 of your grade. See separate handout for details. You may work together in collecting data, however, the write-up of the final report must be uniquely yours. See grading rubric for details.

COMPREHENSIVE FINAL EXAM: NONE!

LATE WORK: Since all labs and other assignments are available within the first few weeks of class, I will not accept ANY late work. Please note, this means ANY!!! You had practically the whole semester to complete the exercise(s), so don't blame broken printers, crashed computers, uncooperative emails, sudden work conflicts or bouts of illness the day(s) before or even during the deadline for missing the deadline. *Hint: Turn your work in early and there will be NO problems!* Since the last deadline is always the last day of your regular scheduled class for the semester, **there will be absolutely NOTHING accepted during and after Finals Week! Don't even try!**

CIVILITY: The student code of conduct will be enforced in this class. The short version of the code: Students are expected to assist in maintaining a classroom environment conducive to learning and respectful of the instructor and fellow students. Students have an



opportunity to gain from time spent in class. Therefore, students are prohibited from using cell-phones or beepers, text messaging, eating or drinking in class, making offensive remarks, reading newspapers, using their laptop or PDA for class unrelated activities (such as browsing the internet, checking email, watching videos, etc.) or doing other assignments unrelated to the class, sleeping or engaging in any other form of distraction. While you may feel that you are doing it quietly and unobtrusive enough, it does indeed distract other students (as scores of them have reported to me). Inappropriate behavior shall result minimally in a request to cease the behavior and upon continuation despite warnings to leave the class.

ELECTRONIC DEVICES: Put ALL your consumer electronics away (which means they are NOT to be visible, even if you don't use them) including but not limited to cell phones, ipods, MP3 players, headphones, etc. They are NOT to be used at any time during my class. Cell phone calculators are NOT ALLOWED, you must bring a "real" calculator. Personal computers are allowed in class only with approval from the instructor and a written and signed contract. Permission for use of PCs will be immediately revoked for the remainder of the course if a student is found to be engaged in unrelated activities, such as checking e-mail, surfing the web, playing games, etc. Texting, emailing, gaming, listening to music or similar unrelated activities during classtime is not only rude and unprofessional, it is highly annoying to me and the majority of your fellow students. If you are caught you will be unceremoniously asked to leave my class and you will lose any or all participation points for that day. Repeat offenders will face disciplinary action on the college level. **You have been warned!**

CELL PHONE WARNING: There are NO cell phones allowed in the classroom! PERIOD! If you text or do anything with your cell phone, **Dr. K has the right to REMOVE YOU FROM THE CLASS. PERIOD!** First infraction will most likely involve a stern, public and very embarrassing warning. Continued infractions will result in a removal from the class and possible failing grades.

LAB TIME: This class requires a lot of lab time. While some time for lab exercises will be given during the assigned lecture block, we have created an open lab schedule outside regular class periods. Please look carefully at the posted calendar and sign-up accordingly. Lab spaces are limited and sign-ups will be taken on a first-come, first-served basis. While you may sign-up for several lab times in advance, keeping these times is a crucial commitment. If you miss ANY of your appointments, ALL your future sign-ups will be bumped in favor of other students willing to keep their commitment. **You have been warned!** Also, be aware that certain labs are only set up during certain times. Missing these labs does not automatically qualify you for a lab make-up at a later date. In fact, these make-ups will be RARELY GRANTED and will need full **official** documentation of circumstances preventing a student from completing the lab during the assigned time slot. **You have been warned again!**

LAB RULES:

ATTN. NEW LAB POLICY IN FORCE

All students needing to work in the lab MUST:

- attend a Lab Safety Lecture, pass a Lab Exam and be certified (Only those will get FOB access and can be in the Lab)
If you are already certified, bring proof
- sign a Lab Liability Waiver
- sign in, state the purpose of their activities
- wear an appropriate name badge identifying you legitimacy to be in the lab
- work in groups of at least two while in the Lab

Students must follow instructions of the Lab Assistants and are responsible for thoroughly cleaning their work space and lab equipment used after the completion of the lab exercise. **BE AWARE: LAB INFRACTIONS CONCERNING EQUIPMENT & CLEAN-UP CARRY MINUS POINTS FOR THE COURSE!** ALL students must read and sign the following Liability Waiver:

LAB LIABILITY WAIVER

- (1) Students in the course will use analytical & cutting machinery as well as assemble chemical kits for rapid mineral field assay to be taken outside of the classroom. All students participating in such lab activities taught by the Department of Earth and Atmospheric Sciences should be aware that there is always an element of risk involved when working with equipment, machinery and/or chemicals. These risks involve serious injury or death, especially if safety protocols are not followed and/or equipment, machinery, and chemicals are misused. Instructors and/or Lab Personnel will use all reasonable precautions and students need to exercise prudent behavior during such activities, but even then there exists the possibility of an accident or injury. Since many of these activities are to be undertaken in the field and outside of the classroom without the direct supervision of an instructor, students must be alert and aware of possible risks and dangers when using chemicals, equipment, and/or machinery with or without supervision.
- (2) Neither the University, nor the instructor, nor any assigned Lab Personnel shall be liable for any damages, including but not limited to injuries, death, loss of property or profits, or incidental, consequential, exemplary, special or other damages that may result from use of chemical, equipment, and/or machinery used in conjunction with or outside the framework of this college course. This condition also expands to the use of procedures and formulations given in LAB texts.
- (3) The associated LAB instructions and described analytical procedures are intended for use by persons with a basic knowledge of



inorganic chemistry, they are advised to follow strictly the safety instructions. Neither the author, nor the instructor, nor the University does accept liability or responsibility for any injury or damage to persons or property incurred by performing the experiments described in the LAB texts, nor for the content of any outside material referred to in class or manual, including linked websites.

(4) EXPLICIT SAFETY RULES & REGULATIONS:

- I. Students MUST wear Safety Goggles when working with chemicals or using equipment or machinery.
 - II. Students MUST read and follow instructions precisely.
 - III. Students shall NOT misappropriate chemicals, equipment and/or machinery other than its intended and prescribed use.
 - IV. Students must take care not to ingest, inhale, taste or otherwise orally contact chemicals or reactive products. Students MUST wash hands after each experiment.
 - V. Some tests may include open flames. Students MUST take precautions in hair and clothing to avoid accidental or intentional contact of persons and property with flames and fire.
 - VI. Students MUST take care when transporting equipment to avoid spillage and unintended contact with property and persons.
- (5) Students who violate any of the above rules, policies and stipulations which are written in this document or implied through instruction and professional laboratory behavior or who fail to conform to directives from the instructor or lab personnel **may be immediately dismissed from the course.** They may also be subject to a failing grade in the course, be required to withdraw from the course, and be subject to disciplinary action by the University.
- (6) All participants **MUST SIGN** the following **LIABILITY WAIVER.**

In consideration of my being permitted to participate in this activity, I, the undersigned hereby release and hold harmless: the Trustees of the Metropolitan State Universities of Denver, the Earth and Atmospheric Sciences Department, and respective employees, from all claims, losses, damages, or expenses because of property damage or personal or bodily injury incurred or caused by me during or in conjunction with the above mentioned activity or activities. In filling out this form, I acknowledge that I fully understand the risk that is inherent with on and off campus laboratory procedures and/or equipment and/or machinery use. The undersigned also indicate with their signature that they will follow appropriate safety rules and regulations. Furthermore, I have fully read and understand the department policies and my liability and do accept the restrictions.

Addendum to ACADEMIC INTEGRITY section below

I-CLICKER: Responding to i-clicker questions for someone else (e.g., by using their i-clicker together with your own) **CONSTITUTES ACADEMIC CHEATING** (same as cheating on a test or exam).

A few but not limited examples of academic dishonesty include cheating, fabrication, and plagiarism, submitting the same paper or work for more than one class, and facilitating academic dishonesty.



Students are responsible for full knowledge of the provisions and regulations pertaining to all aspects of their attendance at MSU Denver, and should familiarize themselves with the policies found in the [MSU Denver Catalog](#).

WITHDRAWAL FROM A COURSE

Students should be aware that any kind of withdrawal can have a negative impact on some types of financial aid and scholarships. For further information, click on read the [Withdrawals](#) page.

The Withdrawal (W) notation is assigned when a student officially withdraws from a course via the Student Hub after the drop deadline (census date) and before the withdrawal deadline posted in the [2016-2017 Academic Calendar](#). Deadlines differ proportionally for courses offered during part of a semester, including late-start and weekend courses. Students should refer to the Student Detail Schedule via the Student Hub to review drop and withdrawal deadlines for individual courses. When a student withdraws from a course, no academic credit is awarded. The course remains on the student's academic record with a "W" notation and counts toward the student's attempted hours. The course is not calculated in the student's GPA or quality points. Students who withdraw from a course are responsible for the full tuition and fees for that course. After the withdrawal deadline, students may not withdraw from a course and will be assigned the grade earned based on the course syllabus. A student-initiated withdrawal will appear as an "F" on the student's academic record in any case of academic misconduct resulting in a permanent "F".

For more information see the [Withdrawal](#) page.

For your drop/refund or Withdrawal dates logon to your STUDENT HUB account and look at your Student Detail Schedule.

ADMINISTRATIVE WITHDRAWAL

The Administrative Withdrawal (AW) notation is assigned when a student requests to be withdrawn from a course due to unforeseen or extenuating circumstances beyond the student's control.

Students may withdrawal themselves online through the withdrawal deadline. Students should meet with an academic advisor prior to withdrawing from a course. After the withdrawal deadline, students may submit a request for AW due to unforeseen or extenuating circumstances.

For more information see [Administrative Withdrawal](#) page.

INCOMPLETE POLICY

The Incomplete (I) notation may be assigned when a student who is achieving satisfactory progress in a course and who has completed most class assignments is unable to take the final examination and/or does not complete all class assignments due to unusual circumstances, such as hospitalization or disability. Incomplete work denoted by the Incomplete "I" notation must be completed within one calendar year or earlier, at the discretion of the faculty member. If the incomplete work is not completed within one year, the "I" notation will convert to an "F." Students must have completed at least 75% of the course work to qualify for consideration for an incomplete. The student must be passing the course in order to be granted an incomplete. The course counts toward the student's attempted hours, does not count toward earned hours, and is not calculated in the GPA or quality points.

Determination of eligibility does not guarantee that an incomplete will be granted. Students who meet the qualifications may request an incomplete from the faculty member who is teaching the course. The decision to grant an incomplete is up to the faculty member or at the department chair's discretion. The decision to grant an incomplete as an accommodation based on a student's disability shall be made by the faculty member or the department chair, if the faculty member is not available, in consultation with the Director of the Access Center.

If an incomplete is granted, the student and instructor should fill out and sign an Incomplete Agreement form to clarify what the student needs to do to complete the course.

For further information see the [Incomplete notation](#) page.



BEST GRADE STANDS

A student's grades for repeated courses will be removed from GPA calculations up to 18 semester hours, regardless of the original grade earned. If a student repeats more than 18 credit hours, the student may designate which of the course grades are removed from GPA calculations (up to 18 semester hours). Only the best grade and its associated credit will be calculated in the GPA and earned hours totals. Other attempts for the course will appear on the official academic record but will be annotated to indicate they do not count for academic credit or GPA calculation. This policy applies only to courses taken at MSU Denver, and it does not apply to courses designated as repeatable toward degree requirements.

For more information see the [Best Grade Stands](#) page.

ACADEMIC INTEGRITY

As students, faculty, staff and administrators of Metropolitan State University of Denver, it is our responsibility to uphold and maintain an academic environment that furthers scholarly inquiry, creative activity and the application of knowledge. We will not tolerate academic dishonesty. We will demonstrate honesty and integrity in all activities related to our learning and scholarship. We will not plagiarize, fabricate information or data, cheat on tests or exams, steal academic material, or submit work to more than one class without full disclosure.

For further information see the [Academic Integrity](#) and [Academic Dishonesty](#) page.

PROHIBITION ON SEXUAL MISCONDUCT

Metropolitan State University of Denver prohibits sexual misconduct in any form, including sexual assault or sexual abuse, sexual harassment, and other forms of nonconsensual sexual conduct, including stalking and electronic harassment. Forms of intimate partner violence, including dating violence and domestic violence, are also prohibited under this policy. Students, faculty, staff and visitors, should be able to live, study, and work in an environment free from sexual misconduct. It is the policy of MSU Denver that sexual misconduct in any form will not be excused or tolerated. Retaliation in any form for reporting such sexual misconduct or for cooperating in a sexual misconduct investigation is strictly prohibited and will be addressed as a separate violation of the Student Code of Conduct. This policy is promulgated under Title IX of the Education Amendments of 1972 (Title IX), 20 U.S.C. §§ 1681 *et seq.*, and its implementing regulations, 34 C.F.R. Part 106; Title IV of the Civil Rights Act of 1964 (42 U.S.C. § 2000c).

For further information, see the [Title IX](#) page and refer to the [Student Code of Conduct](#) page.

ACCOMMODATIONS TO ASSIST INDIVIDUALS WITH DISABILITIES

The Metropolitan State University of Denver is committed to making reasonable accommodations to assist individuals with disabilities in reaching their academic potential. If you have a disability which may impact your performance, attendance, or grades in this class and are requesting accommodations, then you must first register with the Access Center, located in the Plaza Building, Suite 122, 303-556-8387.

The Access Center is the designated department responsible for coordinating accommodations and services for students with disabilities. Accommodations will not be granted prior to my receipt of your faculty notification letter from the Access Center. Please note that accommodations are never provided retroactively (i.e., prior to the receipt of your faculty notification letter.) Once I am in receipt of your official Access Center faculty accommodation letter, I would be happy to meet with you to discuss your accommodations. All discussions will



remain confidential. Further information is available by visiting the [Access Center](#) website.

CLASS ATTENDANCE ON RELIGIOUS HOLIDAYS

Students at MSU Denver who, because of their sincerely held religious beliefs, are unable to attend classes, take examinations, participate in graded activities or submit graded assignments on particular days shall without penalty be excused from such classes and be given a meaningful opportunity to make up such examinations and graded activities or assignments provided that advance written notice that the student will be absent for religious reasons is given to the faculty members during the first two weeks of the semester.

For further information, see the [Class Attendance](#) policies page.

ELECTRONIC COMMUNICATION POLICY

Electronic communication (i.e., email and personal portal announcements) is a rapid, efficient and cost-effective form of communication. Consequently, reliance on electronic communication is expanding among students, faculty, staff and administration at MSU Denver. Because of this increasing reliance and acceptance of electronic communication, forms of electronic communication have become in fact the means of official communication to students, faculty and staff within MSU Denver. This policy acknowledges this fact and formally makes electronic communication an official means of communication for the University.

For more information, see the [Electronic Communication](#) policy page.

FRESH START

Students returning from a period of absence from MSU Denver may request that credit and grades from designated semesters previously attempted at MSU Denver not be calculated in GPA's or total earned hours. If such a "Fresh Start" is approved, all courses from designated semesters will appear on the official academic record but will be annotated to indicate they do not count for academic credit or GPA calculation.

For more information, see the [Fresh Start](#) page.

NOTE: If you have any difficulty accessing the hyperlinks in this document, please inform the instructor.



ADDENDUM: Essential General Knowledge Prerequisites!

It is assumed that you have acquired the following general knowledge skills in the sciences, language, and math through your education up to this point. It is the students FULL responsibility to make-up ANY deficiencies in these areas, preferably before enrolling in the course. I will NOT teach, lecture, or tutor any student in these basic High School skills and general knowledge subjects and no further instruction on the topics listed below will be given.

Basic Office Software

You know how to properly use and command MS Word, MS Powerpoint, MS Excel. Graphing with Excel, putting figures / pictures into Word documents, compiling a short presentation using PowerPoint are expected skills in my course.

English Language

Students should be able to write in short, clear, concise sentences when answering questions. Proper syntax becoming to a college student is expected. In many instances you will also be graded on professionalism which includes expressing yourself accordingly in writing. Unless otherwise instructed, always use third person when writing for the sciences. Usage of "I", "we", "my", "mine", "our", is uncommon in technical writing and needs to be avoided.

Basic Mathematical Operations

Students should be able to do the following mathematical operations without any further instructions:

- Round answer to significant digits
- Doing unit conversions (e.g.; continental drift happens at about 5.5cm/yr. How fast would this be in mph?)
- Percent calculations (e.g.; you measure 2.58g/cm³. The actual density is 2.65g/cm³. What is your percent error?)
- Using **units** in ALL your operations (*I am real stickler about that!*)
- Solving equations for an unknown value; manipulating equations (basic Algebra)
- Basic Geometry: surface areas, volumes, circumferences, areas, angles
- Scientific notations (e.g.; 1.8×10⁻⁹m/s) & scientific prefixes (milli-, mega-, terra-, micro-, etc.)
- Metric system & conversions within (µg, mg, g, kg, t, µm, mm, cm, m, km, m², km², cm³, m³, km³)
- Weights & Measurements (Both American and Metric)
- Operating a scientific calculator (e.g.; know how to switch between degrees and radians, know how to use the arctangent function) $\theta^\circ = \arctan(\text{rise/run})$ *Warning: NO cell phone calculators are allowed!*

Graphing

You are required to be able to differentiate between bar, line and scatter graphs and know how and when each one needs to be constructed. Students should be able to hand-draw curved graphs without being sloppy. Be able to extrapolate values from any graph given, no matter the scale and type. You should also be very familiar with various types of graph paper and how to plot & read data with semi-log and log-log paper.

Physics

Students should be familiar with basic Newtonian laws of motion and understand terms such as velocity, acceleration, inertia, mass vs. weight, force, gravitational constants, kinetic energy, potential energy. Being able to work with the following basic physics equations is a must (Middle School Physics!):

$$v=d/t \quad a=d/t^2 \quad a=(v_f-v_i)/t \quad F=ma \quad I=mv \quad KE=1/2mv^2 \quad PE=ma_g\Delta h \quad a_g=9.8m/s^2 \text{ or } 30ft/s^2$$

Chemistry

Background in basic High School chemistry is essential. Students should know element names and associated symbols, how to read atomic weight and atomic mass from the periodic table, difference between covalent, ionic, metallic and hydrogen bonding, meaning of chemical formulas and subscripts. Students also need to understand pH and the difference between oxidizing and reducing environments. Furthermore, a working knowledge of solutions, solubility, mixtures, homogenous and heterogenous systems, and precipitation is a must.

Geography

Students should know basic physical geography, which includes the location of countries, major mountain ranges, and major rivers.

Drawing & Drafting

While the world is moving rapidly to electronic PC drafting, sketching results by hand is a essential skill in geology. Students must be able to use a drawing compass and a protractor. Sketching curves through data points neat and clean is another requisite skill.