Name:	Course section ID

Grading Rubric

/5   COMPOSITION & LAYOUT - one or multiple point deduction per infraction

The appearance is neat and orderly. The lab is typed and graphics and data are electronically prepared and analyzed. The lab is complete with all fields populated, if any. Graphics and data are placed in a coherent form. Proper formatted citations are included.

/15   WRITING & GRAMMAR - one point deduction per infraction

Spelling and grammar are correct. Word repetition and use of first person language is avoided. Statements are factually correct. Appropriate and complete language is used. Scientific notations / abbreviations as well as subscripts and superscripts are appropriately formatted.

/15   EXECUTION & DATA COLLECTION - one or multiple point deduction per infraction

Appropriate procedural execution of the lab is evident from the writing and data. Procedural detail is adequately mentioned. Tabulated results are presented in an orderly table lay-out. Explanations and inferences are logically drawn and supported by evidence.

/15   GRAPHICS & ILLUSTRATIONS (2 graphs, 1 photo: 5pts ea.) - one or multiple point deduction per infraction

Lab results Are plotted as 1 Linear graph and 1 Logarithmic graph. A photograph of the lab checker board during execution is also included. All illustrations must be electronically prepared. Pictures should be clear, of high quality, and with neutral background. Graphs should have a title with appropriate axis and unit labels. Citation of source must be included. Graphics need to meat minimum resolution (300 DPI) requirements.

Materials:
□ 7 x7 Checkerboard   □ M&M's two colors (20 ea.)

Procedure:
Randomly distribute 20 M&Ms of one color and 20 M&Ms of a different color on the attached 7x7 chessboard The random distribution of colored M&Ms is analogous to the random distribution of Na and K in the high temperature alkali feldspar, anorthosite.

The goal is to have a given M&M of one color completely surrounded by same color neighbors (i.e. 8 nearest neighbors of the same type of M&M located on adjacent edges and the diagonal squares. Each student will sequentially move a M&M into an adjacent open position (horizontal, vertical and diagonal moves are allowed) to achieve this desired configuration. Perfect ordering of colored M&Ms into discrete domains is analogous to perfectly ordered crystals of albite and microcline. [NOTE: in this exercise we are modeling the diffusivity of only the alkali elements, Na and K. The ordering of Si and Al in the tetrahedral sites of a feldspar crystal is a related, but entirely different process].

EXSOLUTION LAB
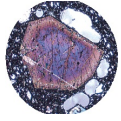
INSTRUCTIONS
For the initial random state, determine the area surrounding each type of element; do this by assuming the unit length along each edge is 1 and add all the surfaces surrounding Na/one color M&Ms and K/other color M&Ms or aggregates of M&Ms. Count any edges that are not adjacent to another same color M&M (i.e. count all one color to other color interfaces, and any edge where a M&M is adjacent to an open space. Do not count the external edges on the outer border of the chessboard).

Make 10 moves of the M&Ms (always moving into an adjacent open space either right, left, up, down, or on a diagonal) and again determine the bounding surface areas. Record these surface area values for the two colors of M&Ms. Repeat after 20, 30, 40, 50, and 100 moves.

After each set of moves, record your surface area measurements for both colored M&Ms on a spread sheet for later plotting and analysis.

This part of the exercise should take about 45 minutes to complete the sets of movements and measurement of the surface areas.

Plot and interpret your results.
1.   Plot your data as instructed. Then produce a 1 page write-up addressing the questions below.
2.   Assume that each move requires 1 unit of time.
3.   Plot your data on a X-Y plot with surface area on the Y axis and time on the X-axis. What is the distribution of your data? (Try plotting data for two colored M&Ms, their sum, and their averages). Create a "best fit" curve through the data as plotted on this X-Y diagram (easily done with functions programmed into Excel).
4.   What type of mathematical function is represented by a curve that has a steep slope to begin (left side of the plot), and becomes asymptotic to the X-axis away from the origin?
5.   Did you notice that the first set of M&M moves produced the largest change in surface area, and that subsequent sets of moves produced smaller and smaller changes to the surface area?
6.   Have you seen other plots with similar profiles from your other studies in Earth Science? Where and what?
7.   Show your answer and mathematical resolution.
8.   Now plot your data on a log-log plot with surface area on the ordinate (Y-axis) and time on the abscissa (X-axis). Create a "best fit" curve through these data (easily done with functions programmed into Excel).
9.   What is the shape of this curve?
10.   Does this relationship demonstrate a) an exponential function? b) a power law?

Write-Up should contain the following:
☐   Title page
☐   Summary of the experiment
☐   A "table" showing your results - *Your table needs a title and table caption*
☐   A "linear" graph of your results with "best fit curve" - *Your graph needs a title and caption*
☐   A "logarithmic" graph of your results with "best fit curve" - *Your graph needs a title and caption*
☐   A write-up answering the above questions
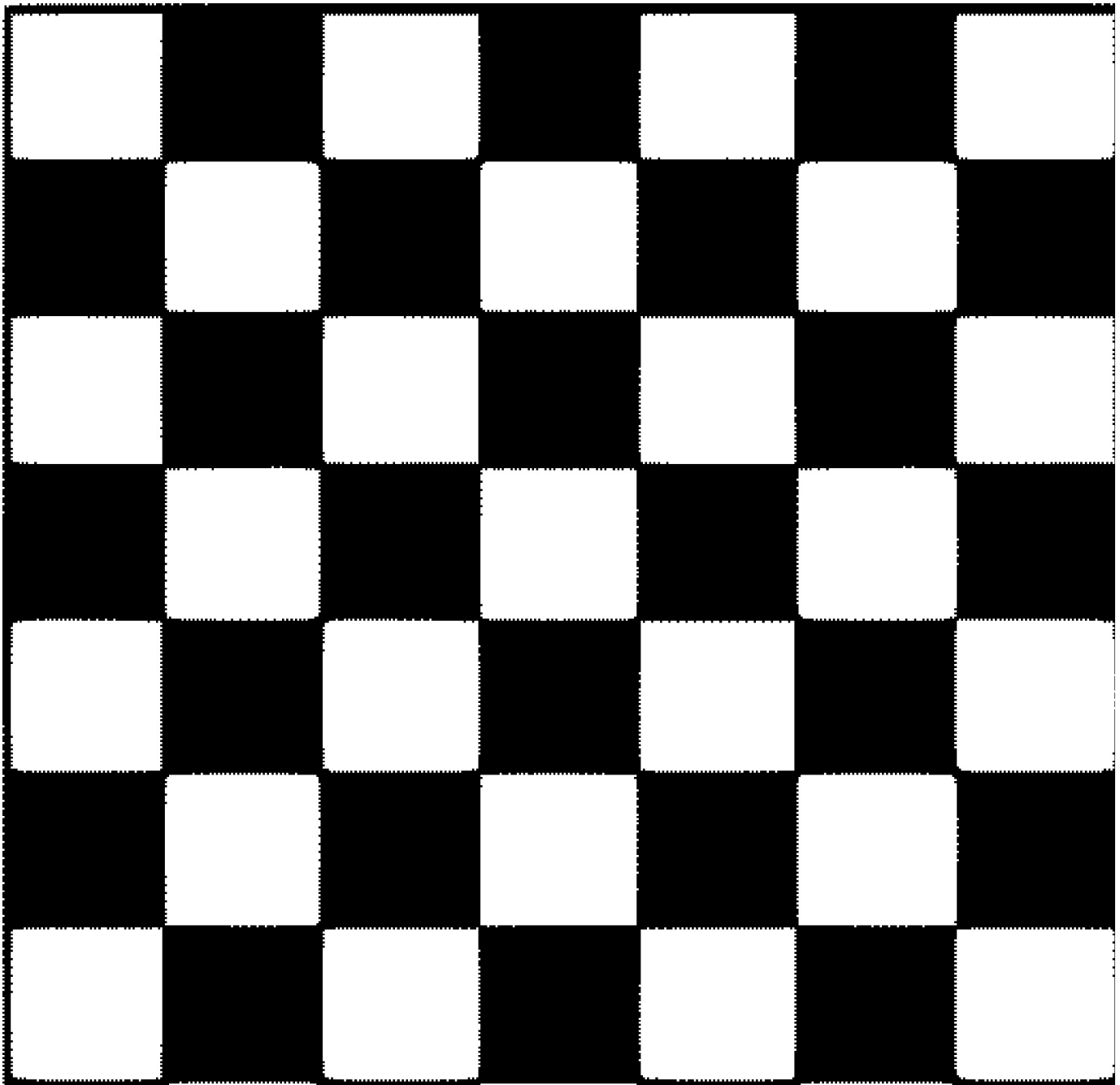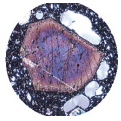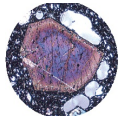
GRADING and NOTATIONS

ALL ANSWERS MUST BE TYPED USING A WORD PROCESSOR! This includes chemical formulas, equations, tables and special characters. Become intimately familiar with these functions in your preferred word processor. Where graphics are indicated insert the proper graphic or picture. Be familiar with placing and sizing visuals into a written document. Attach your completed document(s) to this sheet!

LAB PROCEDURE: You may work with a partner for collecting data and running the lab experiments. However, this is **NOT** a group project. Each individual in the group is responsible for his/her own lab write-up, which includes OWN pictures, data tables, graphics, etc.! Do **NOT** copy and share except for RAW data!!!

For ALL assignments use a citation's database:

ZOTERO citations database	ZOTERO is a citations database that incorporates itself into Word and your Browser.	Free open source software available at https://www.zotero.org/

Note: You may use a different citations database, if desired. But you MUST use a citations database!

NOTE: After downloading and installing ZOTERO, take an hour or two to become familiar with the operation of the software. One of your first tasks will be to set the citation style to the United States Geologics Survey (USGS) format in ZOTERO. The USGS citation system will be required for this course and your final product.

> **Loading the USGS citation format into ZOTERO:** Once Zotero Standalone is installed, click on "Preferences" under the Edit tab. Once there click on "Cite" and go to the "Styles" tab. Click on the "Get additional styles..." below the Styles Manger Box. When the Zotero Styles Repository Window opens, click on the "geology" button within the "Fields" section. A list of geology journals should now appear. Scroll down to the U.S.Geological Survey and click on it. The U.S.G.S style will now be part of your Zotero system and you can set your citations to be formatted accordingly in Zotero.

General Writing Instruction Summary:

- Use professional language, which means AVOID first person expressions such as "I", "we", "our". Use normal prose, active voice and third party language. Do NOT use informal wording, contractions, jargon, slang terms, or superlatives. Exclude similes/metaphors (and humor!)
- Use present tense to report well accepted facts, e.g. 'Pyrite is a sulfide mineral'. Use past tense to describe specific results, e.g. 'When acid was applied, the specimen effervesced'
- Be quantitative wherever relevant (stats, numbers etc.).

| Subscript & Superscript	Use appropriate subscript and superscript, especially when it comes to chemical formulas and mathematical units.. Acceptable examples: 2.9 g/cm^3, H_2O, PO_4^{3-}, $a_g=9.8m/s^2$ Unacceptable examples: 2.9 g/cm3, H2O, PO4 3-, ag=9.8m/s^2

- Use precise concrete language, no ambiguity e.g, 'correlated' ≠ 'related'. Use simple language – no unnecessary "frills" (distractions). Pay attention to sentence structure and grammar

COMPILING TABLES, FIGURES and EQUATIONS

GRAPHICS are the heart of any report. Nothing is more true than in science that a picture is worth a thousand words. Always compile graphics first and then write your text focusing on your graphic. In order to create good graphics and photographs, follow the instructions below.
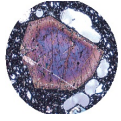
Cameras and Photos:
Cell phones with a 7.2MP camera are usually ok. When taking pictures, lighting and background is key. This means dark objects should be photographed with light or white backgrounds (sheet of paper) and visa versa for light objects. Having adequate lighting will also help to get sharp, crisp, in focus pictures. Blurry and out of focus pictures are not acceptable.

Graphics:
You should be able to modify, enhance, annotate or overlay graphics. Minimum resolution is 300dpi. Make sure graphics are crisp, clear and any label is easily readable. All graphics should have a caption stating the author and/or citation. Preferably use lossless graphic formats, such as .tif or .bmp. Unfortunately .jpg is NOT lossless and will degrade a little every time you open and save it again in order to manipulate picture contents.

> **Graphics Editor Software**: You will need a graphics editor and learn how to use it. Windows comes with its default Windows Paint editor. It is found in the Windows Accessories Folder. For a more advanced option with many more professional features you may try GIMP: https://www.gimp.org/ This is a FREE, open source image editor working across all computing platforms (Windows, Apple, Linux, etc.). The software comes with ample documentation and examples on how to manipulate any picture or graphic.

> **Screen Capture Software:** A screen capture or snipping software is advantageous in order to only grab the part of a graphic from the screen that is important or necessary. Windows 10 comes with a default snipping tools, such as "Snip & Sketch" found in its own folder or "Snipping Tool" found in the Windows Accessaries Folder. Note: When snapping a picture, make sure it is large enough on the screen to capture enough pixels to have adequate resolution for the final product.

NOTE: Compiling acceptable and good looking graphics and photographs is very involved and can not be rushed. These are often the heart of any report and should be compiled BEFORE writing. Last minute thrown together graphics will without doubt lower your grade on the client report significantly.
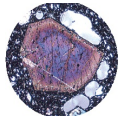
COMPOSITION, LAYOUT, WRITING & GRAMMAR SUMMARY

Language

The following list is an example of common faults in language usage and attribution.

Errors / Mistakes / Faults	Examples with margin *Fault Counts & Codes*	
Spelling:	||	The mineral <u>florite</u> has a <u>mohs</u> hardness of four.
incl. capitalization errors & spacing	|	Nicolas Steno__ was trained in the classical texts on science.
Grammar:		
incl. punctuation, superfluous	|	Isometric crystals are also isotropi<u>c </u>Here light propagates at the same speed.
words, transpositions	||	Rocks are composed of many ~~many~~ minerals mixed.
Style:		
incl. paragraph,	|*Para.*	... in the geologic sciences.¶Near the end of the 19th a new theory ...
repetitive expressions / words	|||*rep*	... is a <u>light colored</u> mineral. These <u>light colored</u> minerals are often <u>light</u>...
erroneous expression / words,	|	Stalactites hang from the <u>sealing?</u> of a limestone cave.
sub- or superscription,	|*sup*	The density of quartz is 2.65 g/cm3.
unprofessional style,	||	<u>I was</u> investigating the outcrop with <u>my</u> group.
word insertion	|	Sodium sulfate forms a chalky, ~~incoherent~~ precipitate. *amorphous?*
		$\wedge$
Sentence:		
incl. grammar,	|	The density of gold is greater <u>then?</u> the density of silver.
run-on,	|	Pyrite has a symmetrical crystal <u>structure, it is</u> cubic.
strings of nouns	||	<u>Skarn mineral zonation?</u> is apparent in the sample.

Content

Errors in content are spelled out. Severe infractions may count for multiple errors.

Errors / Mistakes / Faults	Examples with margin *Fault Counter & Codes*	
Unclear / erroneous statements	|*unclear, units?*	<u>Mohs hardness of the mineral in question is 16.5.</u>
False / nonsense	||*Nonsense*	~~Glaciation cause severe metamorphism of the region~~
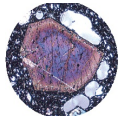
TABLES, FIGURES & EQUATIONS SUMMARY

Tables	Each table must be sufficiently complete that it could stand on its own, separate from text.
	<mark>Only HORIZONTAL lines are allowed in tables. Do NOT use any VERTICAL lines.</mark>
	DO consecutively number and caption tables and refer to them accordingly within your text. Captions go ABOVE the table.
	DO provide a short description of your table within the caption.
	DO place your tables appropriately, closest to their mention in the text.
	DO make sure tables are legible and reproduce well. Print can be smaller than text, with an 8pt size minimum.
	DO appropriately label columns. Do NOT forget units for numeric values.
	AVOID splitting tables across pages.
Figures	Each figure must be sufficiently complete that it could stand on its own, separate from text.
	DO number and caption figures consecutively and refer to them accordingly within your text. Captions go BELOW the figure.
	DO provide a short description of your figure within the caption.
	DO place your figures appropriately, closest to their mention in the text.
	DO use appropriate citations for figures that are NOT your own. If you use a figure that has been modified by you, the phrase "modified after...." is most appropriate. Photos should show the name of the photographer.
	DO make sure figures are legible and reproduce well. Print can be smaller than text, with an 8pt size minimum. Use a minimum resolution of 300dpi. This is a common publication standard.
	AVOID cluttering of figures with too much detail. Simplify if necessary.
	AVOID moire patterns in photos, a nuisance in copied or scanned pictures. Most scanners come with a moire pattern removal tool.
	GRAPHS
	<mark>Understand graphs: Bar graphs and/or line graphs are used when plotting nominal vs. ratio or interval data. Scatter plot graphs are used when plotting numeric vs. numeric data.</mark>
	DO make sure that the graph axis are appropriately labeled and scaled. Axis should have titles as well as scalar units.
	DO use electronic means to generated graphs. Hand drawn graphs are <u>no longer acceptable</u>.
Equations & Computations	☐ Equations should contain explanation of symbols used.
	☐ A reader should be able to follow where your values or numbers come from. Indicate accordingly.
	☐ WRITE DOWN UNITS!!!!
	☐ Show equations used before indicating any computation

Acceptable Example: $F = m \times a = 0.034 kg \times 9.8\ m/s^2 = 0.33\ kgm/s^2$

where m is mass of the object in kg as determined with a triple beam balance and a is the gravitational acceleration. F indicates force expressed in kgm/s^2 or N (Newtons).

Unacceptable example: The answer is 0.33. This is obtained by multiplying gravity by 0.034.