**Martian Research Project**

**Purpose:** To identify and propose an original research question related to Mars then to collect quantitative data, analyze the data, summarize your findings, and present your results in a poster.

**Philosophy**: Participating in an authentic research experience (one conceived, designed, carried out, and presented by you) is an extremely important part of scientific training. Planetary science (and Mars in particular) is an ideal place for this exploration…the missions exploring our Solar System are return terabytes of data everyday…so fast that it cannot be analyzed by NASA or faculty or even graduate students. Interesting, unique, original questions have ‘answers’ waiting to be discovered by you. In addition, the Martian community has a useful server of data (JMARS) that makes accessing this data (relatively) easy and free. The laboratory component of this course is designed around an original research project. First we will learn some basics about Mars and how to use some of the tools available to us (JMARS, data bases, etc.). Then you will work in pairs (or alone if you prefer) to develop an original research question for which you can collect quantitative data. You will collect this data, analyze it, and present the results in a poster presentation. As such, this laboratory research project may be different than some of the previous labs you may have experienced. After we learn our specific techniques together (in September), you will be designing and implementing your own lab procedures. Each group will have a unique approach (though we will all be working together), and each group will have a unique outcome. Just like with ‘real’ research – we do not know the answer to the question you propose (if we did – it wouldn’t be research!!!). Therefore, the object isn’t to ‘get the right answer’ – it is to follow the scientific process and successful complete your analysis to evaluate your research question. In the end you may find that your research question was off-base (or even flat out wrong). You may find that the analysis you completed created more questions than answers. You may discover a completely unexpected result. That is OK – that is how science works. Along the way you will be completing benchmarks and as you move forward with your project as long as you stay true to the scientific method – then you have learned the most important thing for this assignment.

**Outcomes**: The most important outcome of this project is that you will have participated in a research project of your own design. This involves learning and applying skills such as defining questions, identifying resources, interpreting results, and communicating analysis. These are vital skills for any scientist, educator, or professional! I do not expect you will ‘become planetary scientists’ or that this project will become your life’s work. Rather it is designed to serve as a template that you can apply to other research questions (in any field) as you move forward in your educational and professional careers. There will be an option for interested students with rigorous projects to submit their results as an abstract to a regional professional meeting and present their poster at a professional conference. Again, this is an incredible opportunity to present your findings in a professional setting (and an important thing to list on a resume or CV!), network for future internships/jobs, and communicate your scientific results to a varied audience.

**Groups and Grades:**

You may choose to work on this project individually or in pairs. If you work in pairs, then you agree to share the SAME grade for the project (except that each student must turn in an individual annotated bibliography.) Pairs will share the same research question but be expected to carry out a larger quantity of data analysis in their project than those working as individuals. Pairs will share the same poster presentation. In week six we will identify our research groups/general question directions together with input from each individual and the instructor. At that time, pairs will be asked to develop and sign an agreement stating they will share the work and credit for the joint project for the duration of the semester. Individuals cannot ‘join up’ later and must remain as solo investigators if they choose to work independently. Through out the project we will (hopefully!) find that some of the projects relates to each other and it is acceptable and encouraged that you will cite the results of your class colleagues when drawing your own conclusions where appropriate.

**Timeline:**

This is a semester long project that is designed for the laboratory component. Here is how we are going to accomplish this:

Week 1: Introduction to class/project

Week 2: Background lectures on Mars

Week 3: Background lectures on Mars, Technique Lab #1 (introduction to JMARS)

Week 4: Technique Lab #2, (Using JMARS)

Week 5: Technique Lab #3 (Crater counting)

Week 6: Technique Lab #4 (Data bases, other resources), Form research groups

Week 7: Initial research proposal due (see separate assignment)

Week 8: Annotated bibliography due (see separate assignment)

Week 9: Initial data collection due, revised research plan (see separate assignment)

Week 10: Data collection, project work days

Week 11: Progress report #1 due

Week 12: Progress report #2 due

Week 13: Initial results presentation

Week 14: Poster abstract due (see separate assignment)

Week 15: Poster draft due (see separate assignment)

Week 16: Poster Session (during final exam period)

These deadlines are on the course schedule and explained as individual assignments.

**Lab notebook and expectations:**

For this project you will be keeping a research lab notebook. This is where you will be recording your progress and the details of your research. Everything from your major research question, to important references, to how you named your data files! Part of doing research is keeping track of the details. Typically, during each week the second half of class (from 1-1:50) will be set aside for the research project. Sometimes we will have large group meetings where each group quickly presents their recent results or challenges, other times I will have small meetings with sub-sets of the class, and still other times will be independent work time where you decide the task and I am available to interact with you. My expectation is that you will be in class/lab the entire time working on the class assignments, even if there is nothing ‘assigned’ due at the end of class. You will not be successful with this project if you go off on your own or wait until the last minute. Therefore, we need to work together, as a research group, on our independent questions. If you leave early, your project grade will be decreased accordingly.

*Brief description of assignments in research project – grade percentage are for total grade out of the course (combined project is equal to 50% of your course grade). Complete assignments and rubrics will be distributed shortly – but this gives you an idea of what to expect.*

**Technique Labs (10%)**

4 labs designed to introduce you to Martian data sets. Graded pass/fail. Labs must be ‘passed’ to continue on.

**Initial Research Proposal (~1 page) (10%)**

* + - Title of research project
		- Research question – clearly stated objective that can be tested using a quantitative data
		- Proposed methods and data collection
		- Significance of the proposed research
		- Reference list

**Annotated bibliography (10% - individual grades even for pairs)**

You should hand in an annotated bibliography of no less than **six** references from the primary scientific literature. An annotated bibliography is a list of citations with a brief summary of the key points of the article in your own words (~100-200 words). This should not be a copy of the abstract. This will be a great resource to have on hand when you come to write your proposals and final papers. This will be a starting point to refine your research question, data collection, and place the significance of your research in context.

**Revised Research plan (5%)**

Revised research question including detailed task timeline for data collection and analysis.

**Progress Reports (2 for a total of 5%)**

Short (less than 5 min) presentation of initial results/obstacles/techniques with specific goals to be accomplished in the next week. Assessment will be based on how identified tasks are accomplished and scientific rigor.

**Poster Presentation (10%)**

Assessment of final research results include the scientific rigor of the analysis and presentation of results. Includes both presentation of poster and short ‘poster’ talk to be presented in a research symposium during the final exam.

**Martian Research Project**

**Initial Research Proposal (~1 page)**

**Full Draft Due October 10th, with final due Oct 15th (10% of class grade)**

The purpose of the initial research proposal is to identify the question you will be researching, articulate your proposed methods/data collection, and postulate the significance of your results. After reading this document, the reader should have a general idea of the scope and methodology of the proposed research.

Details: This proposal should be typed in 12 pt standard font, single-spaced with standard margins using correct grammar and spelling. You may use bulleted lists, graphs, charts, diagrams as appropriate to your project, but you do not need to. This proposal should be approximately 1 page.

**Components:**

Title of research project

This is a short phrase describing the project.

Research question

This clearly stated objective that can be tested using quantitative data. It clearly articulates the purpose of your research proposal. A research question should be a short statement (no more than two sentences) describing the objective and approach for your project and use quantitative words to describe how you will investigate it. It should help lead people into your interesting study.

Proposed methods and data collection

This section described how you will address your research question. Describe the type of data (MOLA elevation data, HRSC images) and what measurements you will be taking. If you are using existing results (like another researcher’s study, map or model) to compare to data, it should describe what type of comparisons it will be making. This section should outline the resources (both data, computers, and references) that you will be putting together. You do not need to report results or specific data in the initial research proposal, just describe how you will begin to collect them.

Significance of the proposed research

This brief section should relate your results to other studies on Mars or outstanding scientific questions. It is acceptable to say things like, ‘this study will be able to compare recent results to older models to test for…’ You don’t have to (and shouldn’t!) imply that you’ll be solving the major planetary questions (i. e. This study will determine if there was enough liquid water for life to start).

Reference list

All references for this project will be in the format of the Meteoritic and Planetary Science Journal. See the separate handout regarding reference formatting. All material should be referenced and cited. The reference list does not count toward the one page.

**Assessment:**

The research proposal will be assessed on the following characteristics on a scale of

1 – Unacceptable

2 – Poor

3 – Fair

4 – Good

5 – Very good/excellent

The proposed project is scientifically sound.

The proposed project can be assessed using quantitative data.

The research question is clearly stated.

The proposed methods address the stated research question.

The proposed methods clearly describe the data needed for the project.

The proposed project is reasonable in scope for the given time.

The proposed research is appropriately described with regard to significance.

The proposal identifies some relevant associated sources (either in methods or significance sections)

The material including in the proposal is correctly cited.

The references are properly formatted.

The proposal flows well and communicates effectively.

**Martian Research Project**

**Annotated bibliography (10% - individual grades even for pairs)**

**Due Oct 17th\***

You should hand in an annotated bibliography of no less than **six** references from the primary scientific literature. (see lab 4) These references should be associated with your research topic. An annotated bibliography is a list of citations with a brief summary of the key points of the article in your own words (~100-200 words). This should not be a copy of the abstract! This will be a starting point to refine your research question, data collection, and place the significance of your research in context. You will be using them when you present your final results in your poster. The references should be formatted according the MAPS citation guide linked on D2L.

*For reference - at the top of the page put your 1-2 sentence research question.*

An example (with a 150 word summary):

Smith A. B., Jones C. D., and Brown E. F. 2010. Role of Milky Way Candy Bars in Galaxy Development. Candy Bar Reviews XX:XXX–XXX.

The findings indicate that Milky Way candy bars are fundamental components in the formation of galaxies because of their nut-free, chewy nougat. The study took spectra from a variety of candy bars and compared them to the spectra of forming galaxies. They also examined individual components of the candy bars as well as the whole candy bar. There was a negative correlation in candy bars with nuts. Nut-free candy bars had highly variable results, but the Milky Way was found to have the most similar spectral signatures both as a whole bar and in individual components. The researchers concluded that Milky Way was the best-fit candy bar for the galaxy spectra. These finding contradict the results from the Snickers group who found that peanuts were an integral aspect of galaxy formation. This method can be applied to other types of candy bars or sweets.

Evaluation Rubric (for each of the 6 papers.)

Paper is properly cited.

Paper is relevant to the proposed research topic.

The summary is the appropriate length.

The summary focuses on the scientific key points of the paper.

The summary is clearly written.

On a scale of 1-5 where

1 – Unacceptable, 2 – Poor, 3 – Fair, 4 – Good, and 5 – Very good/excellent

\*I will accept this assignment in two parts. 4 abstract summaries are due on Thursday at the end of lab. You may turn in the other 2 by Monday (October 21st) at NOON on D2L or in my office.

**Revised research proposal & Data collection plan**

Martian Research Project (5%)

Due end of lab Thursday October 17th

Late assignments will be decreased 10% per day

The objective of this revised research proposal is to update your research question and to articulate a clear data collection plan with example data collection/analysis. This will allow you to identify the steps for data collection over the next week in a focused, clear manner. This short document should clearly articulate what data you will be collecting, what analysis you will be completing, what data you need to assemble (from other studies) to compare to, etc and estimate the amount of time needed for each task and get a clear goal for your first progress report (due on Nov 5th).

Components

**Research question/statement**: Clear, focused question/statement that can be assessed using quantitative data.

**Research methods/Data collection methods**: Detailed steps including what data/analysis techniques will be used. This can be a structured list rather than paragraph form. The steps should be such that another classmate (or Dr. Kraal) could reasonably follow them as well. It might help you to think that you are ‘writing a technique lab’ teaching someone else how to do this. If it involves data analysis or comparison that you cannot complete until later, project the steps as best you can with as much detail as possible.

**Example data**: Include a sample of your collected data (this could be a preliminary map, topographic profile, compositional analysis, etc).

**Timeline**: Articulate the main tasks from your research methods (above) and estimate the amount of time it will take you to complete these tasks. How many times will you repeat this analysis? (for example you might have a short time to complete a topographic profile and spectral analysis, like 30 minutes, and plan on doing 8 different locations, or you might have a time intensive task that is only repeated once or twice.) If you are in a group, identify who will be responsible for which task/aspect of a task.

**Progress report goal**: What is your specific goal for your first progress report (Nov 5th). This goal should be ambitious, but attainable. You will have an entire week to focus on your data collection, so this goal should represent significant progress toward addressing your research question. If your goal is not appropriate, I will ask you to revise your goal.

Evaluation:

The research question clearly stated and relevant to the project.

The methods address the research question.

Specific data/analysis are described in the research methods.

The methods are clearly described in sufficient detail for repetition.

The example data illustrates the methods

The timeline encompasses the major method steps

The timeline has reasonable time estimates

The goal is appropriate in scope and detail.

On a scale of 1-5 where

1 – Unacceptable, 2 – Poor, 3 – Fair, 4 – Good, and 5 – Very good/excellent

**Research Progress Report:**

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Two total, due Nov 5th and 12th

You will present your preliminary results to the class in the form of a 1 to 2 slide presentation showing graphs, results, analysis, maps, etc. These slides should NOT be a text list of what you’ve done – they should SHOW your results. You will be limited to 3 minutes (individual presentations) or 5 minutes (pairs). You will be assessed both on your accomplishment of your goal and the preliminary results/analysis. I will compare your progress report to your previous goal. The progress report must be uploaded to D2L PRIOR to arriving in class. The slides will be projected during lab for presentation to the class.

Your progress report should include:

- your research question/statement – single, focused sentence with your primary research question.

- brief description of your methods

- preliminary results (showing graphically/visually in a manner appropriate to your project and data collection)

- articulation of challenges/obstacles

- clear statement of goal for the coming week research.

This requires a bit of practice to speak effectively in a short period of time. The objective is to communicate a ‘progress report of data collection’ – not to go into background, meaning, analysis, etc.

Mars Research Project

Poster guidelines

***Basic Information:***

A powerpoint slide template (blank) will be on D2L for you to download in the appropriately formatted size. If you choose to use another program to design your poster make sure it is formatted for the size requirements below.

**Size**: 42 x 48(?) inches

**Title**: Clear and concise, located across the top of the poster

**Authors**: including contact information (professional email address)

**Abstract**: located in the upper left corner of the poster

**Fonts**: Legible fonts that can be read from a distance of 2 meters. Text (including paragraphs and figure captions) should be a minimum of 24 pt (0.9 cm in height) and headers/titles AT LEAST 36 point (1.2 cm) font. Emphasis including bolding, underline, italics should emphasis meaning and be consistent within the poster.

**Figures**: must have a title, labeled axis, and identify all symbols and lines within the graph/figure.

**Organization**: clearly, orderly, self-explanatory – you have freedom to use figures, tables, text, photographs, diagrams, etc to present your research. You may (should) use squares, rectangles, circles, arrows, color shading to group similar ideas. Label elements clearly (such as I, II, III or A, B, C) to help your viewers progress through the research.

**Colors/Background**: must enhance the presentation and should not detract from the presentation of material.

**References**: Cited using the MAPS guide (handed out and on D2L) in text approach within the main text of the poster and a small reference section in the lower part of the poster.

Useful resources for making posters:

<http://www.nature.com/naturejobs/science/articles/10.1038/nj7387-113a>

<http://colinpurrington.com/tips/academic/posterdesign>

**Abstract**

1500-2000 (max) characters (not counting spaces) that summarizes your research question, methods, findings, and conclusions using direct language and statements.

**Poster Presentation:**

You will present your poster to the class and other invited faculty. You should be prepared to describe your research question, methods, and results in a poster ‘walk through’ that takes about 3-5 minutes. You will also be expected to visit colleagues posters, listen to their poster presentations, and ask questions about their findings. At the end of the poster presentation, I will collect your posters as your final exam and assess them. You may pick them back up after they are graded either at the end of final exams or the beginning of the next semester.

**Deadlines:**

Abstract draft due: Nov 26th (I also recommend having a sketch outline of your poster structure)

Poster Draft due: Dec 3rd

Poster printing:

Poster presentation: Dec 10th (11:00 – 1:00)

Evaluation Rubric for poster (out of 200 points)

Poster: 150 pts

1. (15) Abstract – appropriate length, clearly written, describes all aspects of the research including question, methods, results, and conclusions.
2. (10) Citations for research papers and figures (as appropriate)
3. (5) Title
4. (30) Overall visual impact of the poster: Layout, ease of reading, attention to detail
	1. Does the information flow or is it hard to read? Do the colors/fonts assist the reader in understanding the science presented? Is the organization logical and obvious? Does the writing enhance the presentation - is it clear without spelling/grammar errors? Are the figures clear (i.e. not blurry)?
5. (90) Content:
	1. (45) Presentation of research:
		1. Are the methods clearly described in a manner that could be reproduced by another scientist? Are the methods appropriate to address the research question and scientifically rigorous?
		2. Are the data presented in an accurate fashion. Graphs and figures have appropriate titles, labels, figure captions, etc. The data are related to the methods described in the poster. Are the data you show relevant to the study? Did you include a location map if appropriate?
	2. (45) Interpretation of research data: Discussion and conclusions
		1. Do your interpretations match the data?
		2. Does your poster demonstrate that you have a clear understanding of the subject?
		3. Did you come to your own conclusions based on the review of your research and relate it to other sources/studies (where appropriate)?

Poster presentation: 50 pts

1. (30) A tour of the poster: 3-5 minute summary of your research project. Must include importance/context, results, and conclusions or summary.
2. (10) Poise, enthusiasm, and professionalism.
3. (10) Knowledgeable participation in discussion with audience and ability to answer questions.