

**(B) Student Sheet #1. Questions and Hypotheses (1 of 4)**

NAME: \_\_\_\_\_

Did you know that many times scientists start with a big question in mind before they even have a research question or hypothesis? This often occurs as a result of very specific scientific observation, such as the observations you made in Mars Image Analysis. These big questions often lead to possible explanations. We call these explanations hypotheses. You may even already have a big question and an hypothesis about your topic! Below you will find a description of what is meant by a “big picture question,” an hypothesis, and a research question.

**Big picture questions** are the initial questions a scientist will ask while making observations. When researchers observe a feature that is interesting or unique, they will often ask themselves “What is that? How did it form? Why does it appear this way? or Why is this different from other examples?” One of these questions will be the guiding question for the remainder of their research or even possibly their career!

**Hypotheses** often result from these “big picture questions.” These are in the form of potential answers or explanations for the observation. There can be many working hypotheses that are an attempt to answer the question. Each hypothesis is specific to the data that will be collected. The hypotheses must be testable and falsifiable. This means an answer can be found and the answer can either support or refute the hypothesis.

**Research questions** are the best explanations to the big picture questions. Research questions are specific to the data that will be collected. Results from each research question can be pooled together to determine the best answer to the big picture question. Sometimes the hypothesis and research question are considered to be the same.

**(C) Student Sheet #2. Identifying the Big Picture Question (1 of 2)**

NAME: \_\_\_\_\_

For this activity, you will need the observations and the topic chosen by your team from the Mars Image Analysis activity. Review the key observations your team used to pick your topic and discuss with your team what was unique and interesting about these observations. Work in a small group to brainstorm some of the big picture questions about your topic. Question prompts have been provided. You are not limited to the number of times you can use a prompt and you might not use all of the prompts. Additional space has been provided in case you want to use a prompt more than once.

What is \_\_\_\_\_?  
(Should be a specific description of an interesting feature you are unable to identify)

How did \_\_\_\_\_ form?  
(Should be a specific feature)

Why does \_\_\_\_\_ appear \_\_\_\_\_?  
(A specific feature and a description of the appearance)

Why is \_\_\_\_\_ different from \_\_\_\_\_?  
\_\_\_\_\_?



**(C) Student Sheet #2. Identifying the Big Picture Question (2 of 2)**

Now that you have a list of possible big picture questions, share your favorite one or two with the team. Explain why you are interested in answering this question and what observations were made that brought you to the question.

**Top 2 Big Picture Questions to share:**

#1:

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This question is interesting and important because:

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#2:

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This question is interesting and important because:

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**(D) Student Sheet #3. Identifying the Explanations (1 of 3)**

NAME: \_\_\_\_\_

As a team, you will now need to debate which Big Picture Question you would like to use. Once your team has selected a Big Picture Question, record it here:

**Big Picture Question:**

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With a big picture question in place, you are ready to start brainstorming possible explanations. Create a list of possible answers or explanations to the Big Picture Question. Work with your small group to create this list.

As you discuss your ideas, they should be **grounded in science**, but can be outside of the box. Just don't go too far outside of the box or it will no longer be grounded in scientific principles.



**(D) Student Sheet #3. Identifying the Explanations (3 of 3)**

NAME: \_\_\_\_\_

With your understanding of what modeling tools you have available, go back to your original brainstorming list and mark out the explanations you will be unable to research because you do not have the modeling tools available. From the remaining list, choose two explanations you would like to share with the team as a possible explanation.

#1:

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#2:

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As a team you will need to debate among all of the possible explanations to determine which is the best. This will be your primary working hypothesis. You may pick a second if it is closely related to the primary. You will revisit this hypothesis after writing your research question to ensure it is testable and falsifiable.

**Primary Working Hypothesis (DRAFT):**

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**(E) Student Sheet #4. Writing a Research Question (1 of 3)**

NAME: \_\_\_\_\_

In order to write a quality research question, you need to consider the information you need to support or refute your explanation (working hypothesis). You will need to consider the variables you intend to collect data on. A variable is something that will be measured or observed in an experiment. Below you will find a list to get you started. This list does not contain all of the possible variables, but has a good amount to get you started. You may have to load *JMARS for MSIP* and start exploring some of the modeling tools available to help you. Create your own list of variables that are specific to your explanation in the area below.

<b>Potential Variables</b>			
<b>Location</b>	<b>Comparisons</b>	<b>Characteristics</b>	<b>Measurements</b>
Region	Similarities	Shape	Length
Distribution	Differences	Type	Diameter
Elevation	Relationships	Texture	Circumference
Lowlands/highlands	Patterns	Quantity	Height

**(E) Student Sheet #4. Writing a Research Question (2 of 3)**

NAME: \_\_\_\_\_

Using your list on the previous page, create at least 2 questions for your research on Mars. These questions should be related to your topic/working hypothesis and be testable. Once you have written your questions, use the Evaluation Criteria in the box below to see if your question qualifies as a testable research question. If you can put a check (✓) in all of the boxes, your question should be good enough for your team to consider for your research.

**Question 1:**


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**Question 2:**


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Question		Evaluation Criteria
1	2	
		Question can be answered using materials available and in the time allotted.
		Question focuses on specific features that can be observed using the JMARS tool and THEMIS images.
		Question does not focus on <b>how</b> the feature formed.
		Question includes observations or is similar to one of these: evidence, similarities, differences, relationship, patterns, etc.
		Question is not a <b>why</b> or <b>how come</b> .



**(E) Student Sheet #4. Writing a Research Question (3 of 3)**

NAME: \_\_\_\_\_

Share your research questions with your team. As a team, debate which question would be the best potential question for your class to research. Decide which final question is the most interesting and answerable question using THEMIS images.

Try not to feel “possessive” of your own created question. Your creation and participation in the team discussions and decisions will help your team select the best and most interesting question to focus on for your research. The chosen question will most likely change slightly or even greatly throughout the project.

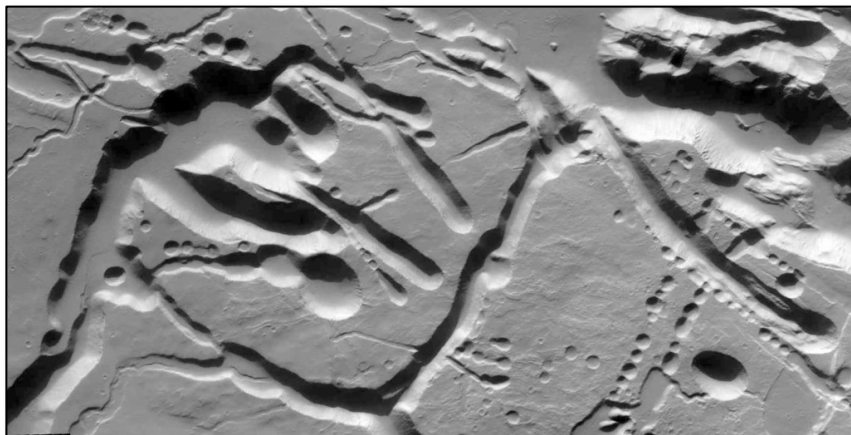
Why is this question the best? List the reasons here:

**Final Science Question:**

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Ascræus Mons Southwest Flank  
NASA/JPL/Arizona State University



**(F) Student Sheet #5. Writing a Testable Hypothesis (1 of 2)**

NAME: \_\_\_\_\_

Refer to your working hypothesis written in Student Sheet #3 and your newly written team question. You will need to modify the hypothesis to more accurately reflect the research question your team has chosen. Once you have written your hypothesis, use the Evaluation Criteria in the box below to see if your hypothesis qualifies as a testable and falsifiable hypothesis. If you can put a check (✓) in all of the boxes, your hypothesis should be good enough for your team to consider for your research.

**Working Hypothesis Draft:**


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**Research Question:**


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**Research Hypothesis:**


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✓	Evaluation Criteria
	Hypothesis can be answered using materials available and in the time allotted.
	Hypothesis focuses on specific features that can be observed using the THEMIS images and JMARS tool.
	Results of the experiment could support the hypothesis OR refute it.
	Hypothesis includes observations or is similar to one of these: evidence, similarities, differences, relationship, patterns, etc.
	Hypothesis could include an 'If...then...' statement, but is not required (*note* not always 100% true. Use if it makes sense.)



**(F) Student Sheet #5. Writing a Testable Hypothesis (2 of 2)**

NAME: \_\_\_\_\_

If it meets the criteria, share your hypothesis with your team. As a team, debate which hypothesis would be the best for your class to research. Decide which hypothesis is the most interesting and answerable question using THEMIS images. You may need to make further observations in JMARS for MSIP to help you identify an appropriate hypothesis.

Try not to feel “possessive” of your own created hypothesis. Your creation and participation in the team discussions and decisions will help your team select the best and most interesting hypothesis to focus on for your research.

Why is this hypothesis the best? List the reasons here:

**Final Science Question:**

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**Final Research Hypothesis:**

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