3D Science Performance Assessment Tasks

MIDDLE SCHOOL

MISSION TO MARS: CAN LIFE BE SUPPORTED?

These materials were developed under a grant awarded by the Michigan Department of Education

Task Title	Mission to Mars: Can Life Be Supported?

Standards Bundle Information
Performance Expectations • MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms • MS-LS1-7: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism
Science and Engineering Practices • Constructing Explanations and Designing Solutions • Developing and Using Models
Cross-Cutting Concepts • Energy and Matter
Disciplinary Core Ideas • LS1.C: Organization for Matter and Energy Flow in Organisms • PS3.D: Energy in Chemical Processes and Everyday Life
CCSS ELA: • SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-LS1-7)* • RST.6-8.1Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-6) • RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. *(MS-LS1-6)* • WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-6) • WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-6)
CCSS Mathematics: • 6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *(MS-LS1-6)*

Overview / Introduction of the Assessment Task

In this task students . . . explore how things grow, food is made, plants and animals obtain food and the differences between matter and energy in photosynthesis. Students apply the knowledge at the end by comparing the needs of humans to a place that is not on earth, such as a biosphere on Mars.

Teacher Background

These performance expectations were bundled with a focus on the cross cutting concept of energy and matter.

Student Project Overview: https://drive.google.com/file/d/0B2yjtfl6PSv7bFZmak9sc1dhUG8/view?usp=sharing

Information for Classroom Use

Connections to Instruction:

This assessment can be taught within the life science and merged with some of the middle school chemistry concepts.

Technology connection: Any of the activities can be incorporated with technology through Google Docs and applied to Google Classroom.

Big Ideas: Photosynthesis is food making process.

Earth is an ideal planet for organisms survival.

Matter is conserved through chemical reactions.

This assessment could be used as a cross curricular assessment with math and ELA.

Approximate Duration for the Summative Task: (all components)

For this entire Performance Assessment, it is estimated to be completed in 3 weeks.

Assumptions:

Students will have had some elementary background on the needs of plants and animals.

Materials Needed:

*An evidence log can be the student record from each of the formative assessments that captures the big ideas and key principles from the activity. A sample of an evidence log can be found at https://drive.google.com/open?id=0B-VVcxQ1TGJqNkhLdTdhTldXZUE

For summative task: Students need a C-E-R template or notebook, photo of Mars landscape

For formative tasks: 1) Photos of seeds and the corresponding adult plant, baby to adult.

2) Bean seeds, small zip plastic bags, paper towels, water access, rulers, grow lights or sunlight

3) Copies of molecules (O_2, CO_2, H_2O, food as glucose) or small models to use as the atoms in photosynthesis such as marshmallows or Legos ©

4) Internet access, library book access for research.

Supplementary Resources:

Molecular model kits and plant "food" sticks.

There are teacher guides for some of the tasks.

Learning Performances
LP -01: Students use the model to predict and describe how energy and matter move through organisms such as plants and animals.
LP-02: Students predict the flow of inputs (sunlight, water and carbon dioxide) and outputs (food/sugars, oxygen) from the plant's food making process.
LP-03: Students develop a model to show how sunlight is needed to cause the carbon dioxide and water molecules to rearrange and form food (sugar/matter) and oxygen.
LP-04: Students develop a model to show how food (sugars) is rearranged through chemical reactions to form new molecules (carbon dioxide, water) and release energy.
LP-05: Students apply the scientific principle that food can be stored for growth for all organisms.
LP-06: Students construct a scientific explanation based on evidence that organisms use food (sugars/matter) for energy and growth and release matter (carbon dioxide and water).
LP-07: Students predict what would happen to animals if plants were removed from an ecosystem.
LP-08: Students observe that matter is conserved through chemical reactions.
LP-09: Students describe how an ecosystem is interdependent upon the organisms and their transfer of energy.

Performance Assessments

<table>
<tr><th colspan="3">Student Performances</th></tr>
<tr><td rowspan="3">Formative Assessment Task 1: Pictures can tell a story</td><td>Learning Performance: LP -01: Students use the model to predict and describe how energy and matter move through organisms such as plants and animals.</td><td rowspan="3">Expected Duration:

2-3 class periods</td></tr>
<tr><td>Description (Phenomena, Scenario, Task)

Students will be shown a picture that includes a seed with an arrow pointing to the mature plant with fruit/vegetables growing on it and a picture of a baby with an arrow pointing to a picture of an adult. Students will be asked: How do organisms get the energy and matter they need to grow?

Examples could include: bean seed; bean plant with beans growing on it, apple seed; apple tree with apples growing on it, tomato seed; tomato plant with tomatoes growing on it, kernel of corn; corn stalk with corn growing on it, squash seed; squash plant with a squash growing on it; sunflower seed; sunflower plant in bloom

Sample picture:
https://drive.google.com/a/howellschools.com/file/d/0B2yjtfl6PSv7c050Zm43ei1BSlk/view?usp=sharing</td></tr>
<tr><td>Directions

This activity will be used to activate student’s prior knowledge and allow the teacher to see a student’s initial understandings around the concepts.

● Teacher provides students the picture and asks them to:
○ Look at the picture and write down in your journal some observations about the pictures.
○ Look at the question, How do organisms get their energy and matter they need to grow?
○ Compare the pictures and write down some of your ideas about how you think they get their energy and matter they need for growth.
○ As you are making observations and comparing the pictures, you may have some questions.
○ Please record any questions you have on sticky notes.
○ Teacher walks around looking at student ideas-checking for understanding, patterns,</td></tr>
</table>

	misconceptions that may need to be addressed at a later time. ● After students have had an opportunity to make observations, compare and record ideas, and record their questions, ask students to share their thoughts with their shoulder partner. After sharing, discuss the following with your partner. ○ What are some similarities we had? ○ What are some differences? ○ What questions did we have? ● Whole group returns: Teacher explains that some student may have had similar and different ideas. We may have had questions because we were confused about something in the question or picture, or we may have needed or wanted more information. Let's share some of the questions we had and post them on the board. ○ Provide an opportunity for students to read their questions and post them for the class. ○ Wrap up: so we have a lot of questions around this picture and the question. These will help guide our learning and give us some focus. ○ The class conclusions can be documented on the evidence log how organisms grow. https://drive.google.com/open?id=0B-VVcxQ1TGJqNkhLdTdhTldXZUE ● Teacher asks students if there are a few who would be willing to share their ideas/thoughts around the question/picture with the class. ○ Have a few students share their ideas. ■ Teacher pauses, paraphrases, and poses questions for clarification. (Allows students to put ideas on the table without correcting thoughts/ideas.) ■ Teacher wraps up: so we have a lot of ideas around this picture and the question. Over the next few weeks we will be learning more about how plants and animals get the energy and matter they need to grow to help us better understand these concepts.	

	Scoring / Teacher Look-For's: ● Do students know where plants get their energy? ● Do students know that plants make their own food? ● Do students know what materials are needed by plants in the food making process? ● Do students know that animals cannot make their own food and that they rely on other organisms for their food? ● Do students know what food is? ● Do students mention "food making" or photosynthesis? ● What misconceptions are surfacing in regards to student understanding around the concepts? ● What questions do students have or what things are they grappling with? ● Are there clusters of students who have similar levels of understanding?	
Formative Assessment Task 2: ***Growing a Seed***	Learning Performance: LP-02: Students predict the flow of inputs (sunlight, water and carbon dioxide) and outputs (food/sugars, oxygen) from the plant's food making process.	Expected Duration: 5-10 class periods
	Description (Phenomena, Scenario, Task) Inquiry Investigation: Design an experiment to determine what materials are needed for plants to grow	
	Directions This activity is used to help students determine what materials are needed for plants to live and grow. ● Teacher explains to students that we have been learning about how plants and animals get the energy and matter they need to grow. ● Teacher poses the following questions and asks students to record their thoughts in their journal; How do plants get their energy? What is matter and where does it come from? What materials are needed for plants to grow? ● After individual reflection time, teacher brings students back together and provides new directions. ○ In your small groups, your tasks are to <u>share your ideas</u>, and <u>generate a group list</u> of materials that you believe plants need for energy and growth. ■ Share your ideas around the 3 questions. ■ Create a list of materials that plants need to grow.	

	● Teacher brings group back together as a whole group and shows them a model. The model contains a bean seed in a wet paper towel sealed in a ziplock bag. Teacher poses the following questions: ○ How many think this bean seed will grow? ○ How many think it won't grow? ○ What conditions are necessary for the plant to grow? How can we design an experiment that would allow us to determine the fewest amount of materials needed for the plants to grow. ○ You will be working in small groups and your task is to design an investigation that will help you collect evidence to prove what materials are needed for a plant to grow. ○ Your investigation must include: ■ A list of materials you are planning to use. ■ A diagram to show how your model will be set up ■ A plan to describe what you want to test and why ■ As a group you need to determine how you know it is **evidence** that each material is needed for growth. ○ In setting up an experiment like this, what are things we need to control? Why is that important? ■ Class discussion on controls and testing one variable at a time. ○ Teacher asks if students have questions or need clarification? ● Small group time for students to design their investigations making sure to include a list of materials, a diagram, a plan, and what they will collect as evidence. ● After students have the 4 parts of their investigation, they will conference with the teacher and discuss their design. ○ Teacher would pause, paraphrase, ask clarifying questions and provide feedback to the group to help them think through their design. ● Students would set up their experiment, make observations and collect evidence overtime. ● After students have collected data, discussed their findings and come to a conclusion on what is needed by	

	plants for energy and growth, groups will share their information with the class and have discourse around their findings and evidence through guided questioning. ● Look at the class model and compare what it looks like now compared to what it looked like at the start. ○ What do we notice? ○ How has the seed changed? ○ What materials did we include in our bag? ○ How do you think seed was able to grow? ○ What structures do we now observe on the bean plant? ○ How will the bean seed continue to grow? ○ How will its structures become important as it continues to take in energy and have growth? ● As a class we come to consensus on what is needed for plants to live and grow and evidence that supports our ideas. Possible examples-student responses. ○ When the seed only had light hit the bag it did not grow. ○ When the seed only had water and no light, it did not grow. ○ When the seed only had air, it did not grow. ○ When the seed had air, water and light, it did grow. ● Teacher's guided questions: ○ What are some things our experiments/models did well? ○ What are some limitations to our experiments/models? ○ What might we might change in our experiments or models? ○ Did our models help us determine what a plant needs to grow? ○ In thinking about our learning performance, what inputs are necessary for a plant to grow? ■ What is our energy source? ■ What matter is needed for plants to grow? ■ How do you think the plant uses the matter and energy to make its own food? ○ What would be an output from a plant's food making process? ■ What is the food the plant makes for itself so that it can grow?	

	■ What is another name for the "food" that plants make? ■ Are any other outputs from the food making process? ■ Other than being food for other organisms, how do plants help support life? ■ Why are plants necessary to support other organisms on Earth? ● Students can record the discussion on the evidence log about the needs for the food making process. https://drive.google.com/open?id=0B-VVcxQ1TGJqNkhLdTdhTldXZUE ● Give students the article: Plants are Food Factories by Cindy Grigg or similar articles on how food is made. ○ Ask students to read the article and answer the questions.	
	Scoring / Teacher Look-For's: ● Do students include the sun as an energy source for the plant? ● Do students have a list of materials with why they are testing them? ● Do students have a set up design for their model/experiment? ● Do students have a plan for testing? ● Are students testing one variable at a time? ● Have students identified what they will collect as evidence? ● Do students see the materials needed as inputs? ● Do students see that outputs are what is made by plants in the food making process? ● Do students identify sunlight (light), water and carbon dioxide as materials (inputs) that are needed for photosynthesis? ● Do students identify glucose/sugar/food and oxygen as outputs generated through the process of photosynthesis? ● Do students understand why plants are considered "food factories?"	

Formative Assessment Task 3: ***Matter Balance***	Learning Performances: LP-02: Students predict the flow of inputs (sunlight, water and carbon dioxide) and outputs (food/sugars, oxygen) from the plant's food making process. LP04-Students use a model to see how food (sugars) is rearranged through chemical reactions to form new molecules (carbon dioxide, water) and release energy. LP-08: Students observe that matter is conserved through chemical reactions.	Expected Duration: 2 2 class periods
	Description (Phenomena, Scenario, Task) Students will be given a diagram that represents the food making process (photosynthesis). The diagram includes inputs and outputs (energy and the molecules that make up the matter) in the food making process. Students will be given another diagram that includes the process that organisms use to break down food for energy (cellular respiration). The diagram includes inputs and outputs (molecules of matter used for energy and by products released). https://drive.google.com/file/d/0B2yjtfl6PSv7Qk56OXNoLVRva0k/view?usp=sharing Students will analyze the diagrams/models to compare the matter (atoms and molecules) and energy inputs and outputs looking for similarities and differences between the two. Students will use the model to identify the inputs and outputs of chemical reactions to form new molecules and energy conversions. Students will observe that matter is conserved through chemical reactions.	
	Directions *This assessment would follow a series of activities where students make models of the molecules that are present in the atmosphere-water, carbon dioxide, oxygen, and nitrogen, using materials (Legos, marshmallows, skittles, toothpicks) to show that atoms bond together to form molecules. They would also learn that depending on the number and arrangement of molecules different substances form.*	

	Students would have learned that plants have structures that allow the plant to take in the molecules, break them apart and rearrange them within the leaves to make new molecules. Some molecules are stored in the plant, other molecules are released back into the atmosphere. Teacher sets the stage: We have been learning about how organisms get and use the energy and matter needed to grow. Today we will be analyzing 2 models/diagrams that include input and outputs of energy and matter for plant and animal processes. Teacher provides a copy of the Cycling Of Matter and Energy to the students. Teacher asks, ● As you look at the diagram, ○ What questions do you have? ○ What do we mean by inputs? ○ What materials would we label as inputs for the process of photosynthesis? ○ What do we mean by outputs? ○ What materials would we label as outputs for the process of photosynthesis? ○ Label the inputs and outputs for photosynthesis. ○ With your partner, label the inputs and outputs for cellular respiration. ○ Compare your labels with your other table partners. ○ With your table group, analyze the 2 models. ○ On the large sheet of paper at your table, record ■ Similarities and differences ■ Generalizations or true statements about what you see in the models ■ Inferences that you make based on your observations Students work with their table partners to analyze and record similarities and differences, generalizations and inferences. After each group has completed their analysis, a feedback carousel could be used for students to peer assess others ideas and provide feedback Whole group discussion and wrap up of big ideas. Students would add new information/key ideas onto their evidence log. https://drive.google.com/open?id=0B-VVcxQ1TGJqNkhLdTdhTldXZUE	

	Scoring / Teacher Look-For's Students record similarities: ● All of the atoms are carbon, hydrogen and oxygen ● There are the same number of carbon, hydrogen and oxygen atoms on each side of the equation for both diagrams ● The inputs are on the left side and outputs are on the right side ● All of the carbon atoms are black, hydrogen white and oxygen red ● There is energy in both diagrams ● There are water, oxygen, carbon dioxide and glucose molecules in both diagrams Students record differences: ● There are different molecules on different sides of the equations ● The number of atoms are different for the different molecules ● The arrangement of the atoms are different for the different molecules ● The energy is on the left for photosynthesis and on the right for cellular respiration ● The energy type of energy is different in the diagrams Students record generalizations or true statements: ● The number and arrangement of atoms determines the type of matter ● The inputs for photosynthesis are outputs for cellular respiration ● The inputs for cellular respiration are the outputs for photosynthesis Students record inferences: ● Plants create the materials that other organisms need ● Organisms create materials that plants need ● Matter and energy are conserved in chemical reactions because the number and kind of atoms are the same ● Atoms can form different kinds of molecules during a chemical reaction ● Sunlight is the main source of energy for photosynthesis	

Formative Assessment Task 4: ***Goldilocks Conditions***	Learning Performance: LP-02: Students predict the flow of inputs (sunlight, water and carbon dioxide) and outputs (food/sugars, oxygen) from the plant's food making process.	Expected Duration: 1- 2 class periods
	Description (Phenomena, Scenario, Task) A picture of Earth and a picture of Mars Why can Earth sustain life but Mars can't?	
	Directions Time is needed for research on the current conditions of Mars. Think about inputs and outputs. Guiding questions: ● Why can Earth sustain life but Mars can't? ● Why do people plant gardens in the in the spring/summer? As a class, have a discussion on the conditions of Mars. ● What are things plants and animals need to grow? ● What can be reused? ● Which of these factors are found on Mars? ● Which of these factors are NOT found on Mars Allow time for students begin to group conditions into categories as they see fit. Possible categories are: ● Factors in the air, factors on the land, factors in the water. ● Factors used by plants, factors used by animals, factors used by both. ● Factors that taken in and factors that are released. Teacher facilitates for consensus. This can also identify misconceptions about the factors. Have students brainstorm with a small group of peers, the factors that are missing or not directly accessible on Mars (water oxygen). Student teams should journal in their notebooks an answer to: How can each of those missing sources be utilized? Then class discussion to answer: ● Why can Earth sustain life? (the Goldilocks conditions) ● What conditions are needed for organisms to grow? The student can record the discussion in the evidence log as to the conditions needed for life.	

<table>
<tr><td></td><td colspan="2">https://drive.google.com/open?id=0B-VVcxQ1TGJqNkhLdTdhTldXZUE</td><td></td></tr>
<tr><td></td><td colspan="2">Scoring / Teacher Look-For's:

Completed evidence log:

https://drive.google.com/file/d/0B2yjtfl6PSv7RGkwUDNQbVRTN3c/view?usp=sharing

Student Questions to Consider-

● Why can Earth sustain life but Mars can't?
● What conditions are needed for organisms to grow?</td><td></td></tr>
<tr><td>Final Task</td><td colspan="2">Learning Performance:

LP-06: Students construct a scientific explanation based on evidence that organisms use food (sugars/matter) for energy and growth and release matter (carbon dioxide and water).</td><td></td></tr>
<tr><td rowspan="3"></td><td colspan="2">Phenomena: How can life be supported on Mars?

Picture of Mars landscape (samples can be found at: Pics- of space- mars landscape; or NASA Gallery images)</td><td rowspan="3">Expected Duration:

3-4 class periods</td></tr>
<tr><td>Goal: Students produce an scientific explanation that demonstrates understanding for how food (sugar/matter) is made, used and the flow of energy in the biosphere.</td><td>Role:

Astrobiologist for NASA</td></tr>
<tr><td>Audience:

NASA's Mars Colonization Committee (hypothetical)</td><td>Situation: NASA has decided to build a Biosphere on Mars for future colonization. As a scientist, your task will be to analyze the food needs of the colonists and provide scientific reasoning for what is needed.</td></tr>
</table>

	Product / Performance: A scientific explanation (claim, evidence, and reasoning) with support that shows within the biosphere the materials needed to support life on Mars. ● How food is made ● How food is used ● Flow of energy ● Conditions that affect food growth ● Thoughts about whether Mars could support life The scientific explanation is presented to the 'Mars Colonization Committee' Presentation could be a paper, electronic format, Power Point, poster, video clip, audio presentation, etc. Student Project Overview: https://drive.google.com/file/d/0B2yjtfl6PSv7bFZmak9sc1dhUG8/view?usp=sharing	
	Directions: 1. Students are provided the situation. NASA is planning to pursue the colonization of Mars. Remind students to just focus on the biological aspects for the food needs. 2. Using the evidence log* gathered about how organisms get food and use energy to sustain life. To help guide students towards the important vocabulary to use in their evidence and reasoning statements the teacher may choose to have student highlight key words on the evidence log. Students can make a concept map from the common terms, or type in the words as many times as they show up on a Word Cloud generator programs such as Wordle or Tagxedo. Explain that the common words should be used in the evidence and reasoning statements. This exercise will provide the students with vocabulary framework of the key ideas. Sample word cloud generator product: https://drive.google.com/open?id=0B-VVcxQ1TGJqejg5cnZhZ3UwTVE **Remember the evidence log can be the student record from each of the formative assessments that captures the big ideas and key principles from the activity.*	

	3. Students begin to work on developing a Claim - Evidence-Reasoning piece that demonstrates scientific knowledge. From Edutopia website: According to the CER model, an **explanation** consists of: ● A claim that answers the question ○ What do you know? ● Evidence from students' data ○ How do you know that? ● Reasoning that involves a "rule" or scientific principle that describes why the evidence supports the claim ○ Why does your evidence support your claim? Samples of C-E-R templates can be found for free by doing an internet search. 4. Begin by restating the question: How can life be supported on Mars? 5. Students develop a claim stating the factors needed are required for life will be met. ● Claim Example 1: Life can be supported if there is carbon dioxide, water, sunlight and oxygen. ● Claim Example 2: Life can be supported if you are able to grow plants. 6. The claim is supported with evidence from the knowledge and lessons done previously. The evidence log can be used as rationale to this task. The evidence should demonstrate some data from the previous knowledge and lessons. ● Evidence example 1: Plants need sunlight, carbon dioxide and water to make food. ● Evidence example 2: Oxygen and water released by people can be used by plants. ● Evidence example 3: People cannot make food, only plants, algae and microorganisms. 7. Each of the evidence statements should be supported with reasoning from the prior knowledge and lessons. A sentence or two explains why the evidence is relevant to the answer. 8. Time can be spent where students can collaboratively share their products and be able to revise their products.	

CheckBric

Learning Performance: LP-06: Students construct a scientific explanation based on evidence that organisms use food (sugars/matter) for energy and growth and release matter (carbon dioxide and water)					Comments
Evidence Statements below:					
Includes a clear claim, at least three pieces of evidence and a reasoning statement with scientific principle. ● Claim correctly answers the question. ● Evidence describes or provides and sufficient data to support the claim. ● Reasoning describes how and why the evidence supports the claim using appropriate and valid scientific ideas and principles.	1	2	3	4	
Describes the input and outputs of food making process and flow of energy.	1	2	3	4	
Evidence and reasoning statements should include at least three of the following: ● Plants need sunlight (energy source for life), water and carbon dioxide to make their food (sugars/ matter) through photosynthesis. ● Animals get food (sugars) from plants or other animals. ● Plants need sunlight as an energy input to produce complex food molecules (sugars). ● Animals get energy as food (sugars) is broken down by chemical reactions with oxygen and form new molecules to support growth. ● Food (Sugars) can be used or stored for growth or stored for later use.	1	2	3	4	
LP Total:					
Learning Performance: LP-02: Students predict the flow of inputs (sunlight, water and carbon dioxide) and outputs (food/sugars, oxygen) from the plant's food making process.					Comments
Evidence Statements here:					
The explanation has a prediction about how the food making process (photosynthesis) works.	1	2	3	4	
Sunlight, water and carbon dioxide are described as reactants (inputs) and Food/sugars and oxygen are described as products (outputs).	1	2	3	4	
The food making process (photosynthesis) has inputs and outputs.	1	2	3	4	
LP Total:					
Checkbric Total					

4 Exemplary	Work at this level is of exceptional quality. It is both thorough and accurate. It exceeds the standard. It shows a sophisticated application of knowledge and skills.
3 Proficient	Work at this level meets the standard. It is acceptable work that demonstrates application of essential knowledge and skills. Minor errors or omissions do not detract from the overall quality.
2 Developing	Work at this level does not meet the standard. It shows basic, but inconsistent application of knowledge and skills. Minor errors or omissions detract from the overall quality. Your work needs further development.
1 Emerging	Work at this level shows a partial application of knowledge and skills. It is superficial (lacks depth), fragmented or incomplete and needs considerable development. Your work contains errors or omissions.

Item Production Information

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Information Sources:

Brunsell, Eric. *Designing Science Inquiry: Claim + Evidence + Reasoning = Explanation,* Edutopia, September 25, 2012.

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NASA/JPL-Caltech/MSSS, http://mars.nasa.gov/multimedia/images/?ImageID=7496, Mars Landscape picture from NASA Gallery