

National Aeronautics and Space Administration



red rocks

High School NRC Framework Alignment Document



Red Rocks

High School NRC Framework for Science Education Alignment Document



WHAT STUDENTS DO: Explore red rocks of Earth to explain why Mars is red.

Students will explore Karijini Gorge in Australia and Oak Creek Canyon in Oak Creek Canyon, AZ searching for clues to the environments that formed the red rocks there. They will observe these rock formations at a variety of scales to gather these clues. Finally, they will apply their understanding of red rock formation to answer the question “Why is Mars red?”

NRC FRAMEWORK CORE & COMPONENT QUESTIONS

HOW AND WHY IS EARTH CONSTANTLY CHANGING?

NRC Core Question: ESS2: Earth Systems

How do Earth’s major systems interact?

NRC ESS2.A: Earth Materials and Systems

INSTRUCTIONAL OBJECTIVES (IO)

Students will be able to

IO1: Interpret evidence in the rocks of Mars at a variety of scales to explain the presence of iron oxide and what it tells us about water in the ancient/present Martian environment.

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University’s Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University’s Mars Education Program. The lesson and its’ associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

Last edited: April 25, 2018



1.0 About This Activity

How Students Learn: Science in the Classroom (Donovan & Bransford, 2005) advocates the use of a research-based instructional model for improving students' grasp of central science concepts. Based on conceptual-change theory in science education, the 5E Instructional Model (BSCS, 2006) includes five steps for teaching and learning: Engage, Explore, Explain, Elaborate, and Evaluate. The Engage stage is used like a traditional warm-up to pique student curiosity, interest, and other motivation-related behaviors and to assess students' prior knowledge. The Explore step allows students to deepen their understanding and challenges existing preconceptions and misconceptions, offering alternative explanations that help them form new schemata. In Explain, students communicate what they have learned, illustrating initial conceptual change. The Elaborate phase gives students the opportunity to apply their newfound knowledge to novel situations and supports the reinforcement of new schemata or its transfer. Finally, the Evaluate stage serves as a time for students' own formative assessment, as well as for educators' diagnosis of areas of confusion and differentiation of further instruction. The 5E stages can be cyclical and iterative.

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



2.0 Instructional Objectives, Learning Outcomes, Standards, & Rubrics

Instructional objectives and learning outcomes are aligned with

- National Research Council's, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*
- National Governors Association Center for Best Practices (NGA Center) and Council of Chief State School Officers (CCSSO)'s, *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects*
- Partnership for 21st Century Skills, *A Framework for 21st Century Learning*

The following chart provides details on alignment among the core and component NRC questions, instructional objectives, learning outcomes, and educational standards.

- Your **instructional objectives (IO)** for this lesson align with the NRC Framework.
- You will know that you have achieved these instructional objectives if students demonstrate the related **learning outcomes (LO)**, also aligned with the NRC Framework.
- You will know the level to which your students have achieved the learning outcomes by using the suggested **rubrics**.

Important Note: This lesson is color-coded to help teachers identify each of the three dimensions of the NRC Framework. The following identifying colors are used: Practices are blue, Cross-Cutting Concepts are green, and Disciplinary Core Ideas are orange.

This color-coding is consistent with the NRC Framework for K-12 Science Education.

Quick View of Standards Alignment:

This alignment document provides full details of the way in which instructional objectives, learning outcomes, 5E activity procedures, and rubric assessments were derived through, and align with the NRC Framework for K-12 Education. For convenience, a quick view follows:

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



HOW AND WHY IS EARTH CONSTANTLY CHANGING?

NGSS Core Question: ESS2: Earth Systems

How do Earth's major systems interact?

NGSS ESS2.A: Earth Materials and Systems

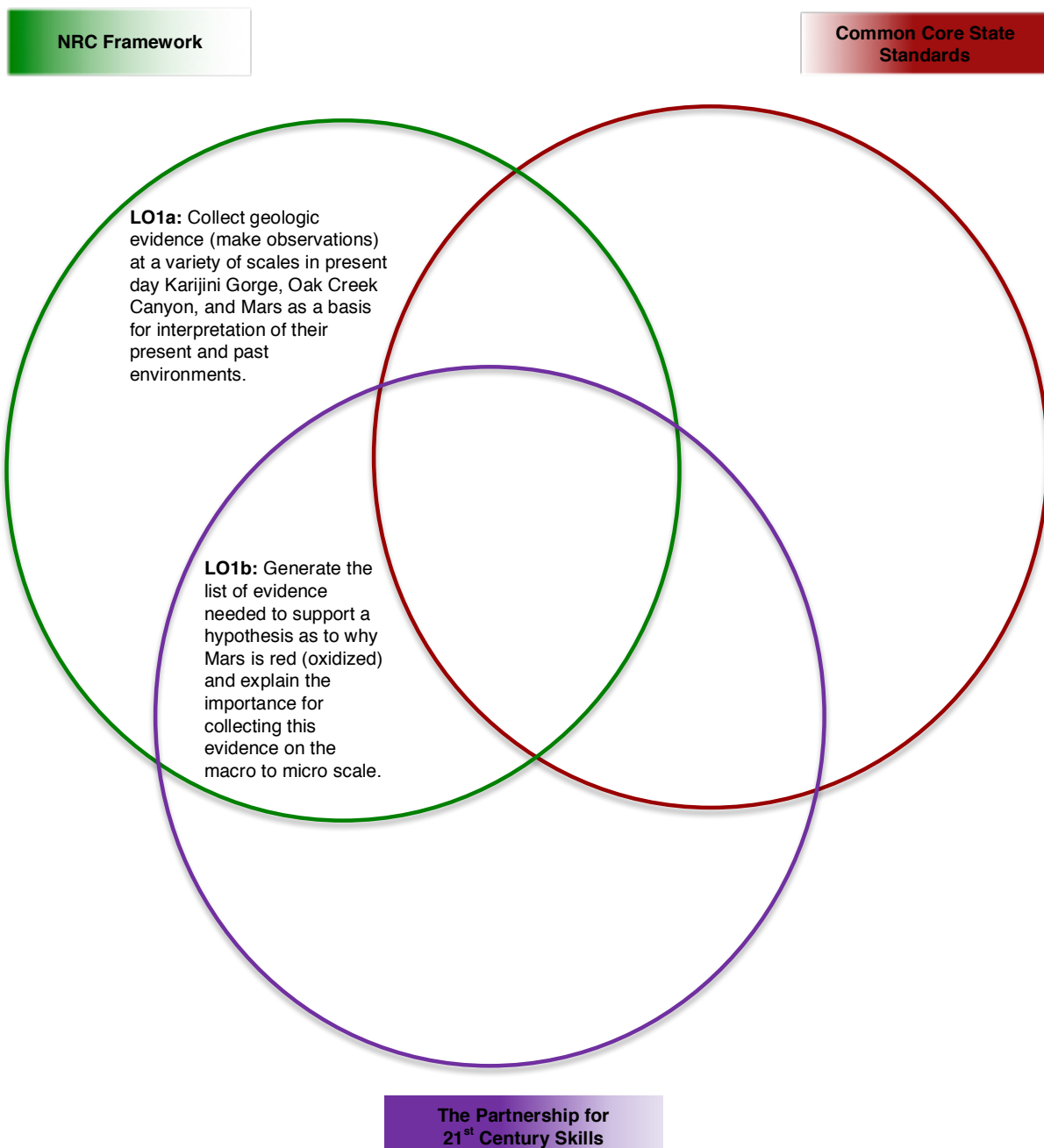
Instructional Objective <i>Students will be able to</i>	Learning Outcomes <i>Students will demonstrate the measurable abilities</i>	Standards <i>Students will address</i>
<p>IO1: Interpret evidence in the rocks of Mars at a variety of scales to explain the presence of iron oxide and what it tells us about water in the ancient/present Martian environment.</p>	<p>LO1a: Collect geologic evidence (make observations) at a variety of scales in present day Karijini Gorge, Oak Creek Canyon, and Mars as a basis for interpretation of their present and past environments.</p> <p>LO1b: Generate the list of evidence needed to support a hypothesis as to why Mars is red (oxidized) and explain the importance for collecting this evidence on the macro to micro scale.</p>	<p>PRACTICES:</p> <ol style="list-style-type: none"> 1. Planning and Carrying Out Investigations 2. Analyzing and Interpreting Data 3. Constructing Explanations and Designing Solutions 4. Engaging in Argument from Evidence <p>Scientific Knowledge is based on Empirical Evidence</p> <p>DISCIPLINARY CORE IDEAS: ESS2.A: Earth Materials and Systems</p> <p>Optional Iron Oxidation Lab PS1.B: Chemical Reactions</p> <p>CROSSCUTTING CONCEPTS:</p> <ol style="list-style-type: none"> 1. Patterns 2. Cause and Effect: Mechanism and Prediction 3. Scale, Proportion, and Quantity 4. Structure and Function <p>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</p>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



3.0 Learning Outcomes, NRC Framework, Common Core, & 21st Century Skills Connections

The connections diagram is used to organize the learning outcomes addressed in the lesson to establish where each will meet the NRC Framework for K-12 Science Education, Common Core Standards, and the 21st Century Skills and visually determine where there are overlaps in these documents. See Common Core State Standards Alignment Document and 21st Century Skills Alignment for details on their specific alignments.



This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



4.0 Evaluation/Assessment

Use the *(N) Red Rocks Rubric* as a formative and summative assessment, allowing students to improve their work and learn from mistakes during class. The rubric evaluates the activities using the NRC Framework for Science Education.

5.0 References

- Bybee, R., Taylor, J., Gardner, A., Van Scotter, P., Carson Powell, J., Westbrook, A., Landes, N. (2006) *The BSCS 5E instructional model: origins, effectiveness, and applications*. Colorado Springs: BSCS.
- Donovan, S. & Bransford, J. D. (2005). *How Students Learn: History, Mathematics, and Science in the Classroom*. Washington, DC: The National Academies Press.
- Miller, Linn, & Gronlund. (2009). *Measurement and assessment in teaching*. Upper Saddle River, NJ: Pearson.
- National Academies Press. (1996, January 1). *National science education standards*. Retrieved February 7, 2011 from http://www.nap.edu/catalog.php?record_id=4962
- National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: Authors.
- National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.
- The Partnership for 21st Century Skills (2011). *A framework for 21st century learning*. Retrieved March 15, 2012 from <http://www.p21.org>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

(M) Teacher Resource. Red Rocks NRC Framework Alignment (1 of 3)

You will know the level to which your students have achieved the **Learning Outcomes**, and thus the **Instructional Objective(s)**, by using the suggested **Rubrics** below.

NRC Framework for K-12 Science Education			
Instructional Objective	Science and Engineering Practices Benchmark by Grade 12	Disciplinary Core Idea Grade Band Endpoints	Crosscutting Concepts
<p>IO1: Interpret evidence in the rocks of Mars at a variety of scales to explain the presence of iron oxide and what it tells us about water in the ancient/present Martian environment.</p>	<p>Analyzing and Interpreting Data Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis.</p> <p>Constructing Explanation and Designing Solutions Offer causal explanations appropriate to their level of scientific knowledge.</p> <p>Engaging in Argument from Evidence Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.</p>	<p>ESS2.A: Earth Materials and Systems Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts.</p> <p>**IF USING IRON OXIDATION LAB IN CLASS TO SUPPORT THIS LESSON, THE FOLLOWING ALSO APPLY**</p> <p>PS1.B Chemical Reactions Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines</p>	<p>Patterns Different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.</p> <p>Cause and Effect: Mechanism and Prediction: Argumentation from students' own explanations of cause and effect.</p> <p>Structure and Function As students develop their understanding of the relationships between structure and function, they should begin to apply this knowledge when investigating phenomena that are unfamiliar to them. They recognize that often the first step in deciphering how a system works is to examine in detail what it is made of and the shapes of its parts.</p>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



		<p>the numbers of all types of molecules present.</p> <p>The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. Chemical processes and properties of materials underlie many important biological and geophysical phenomena.</p>	
--	--	---	--

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



(M) Teacher Resource. Red Rocks NRC Framework Alignment (2 of 3)

NRC Framework for K-12 Science Education			
Learning Outcomes	Science and Engineering Practices Benchmark by Grade 12	Disciplinary Core Idea Grade Band Endpoints	Crosscutting Concepts
<p>LO1a: Collect geologic evidence (make observations) at a variety of scales in present day Karijini Gorge, Oak Creek Canyon, and Mars as a basis for interpretation of their past environments.</p>	<p>Analyzing and Interpreting Data Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis.</p> <p>Planning and Carrying Out Investigations Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded.</p> <p>Engaging in Argument from Evidence Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.</p>	<p>ESS2.A: Earth Materials and Systems Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts.</p> <p>**IF USING IRON OXIDATION LAB IN CLASS TO SUPPORT THIS LESSON, THE FOLLOWING ALSO APPLY**</p> <p>PS1.B Chemical Reactions Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.</p>	<p>Patterns Different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.</p> <p>Structure and Function As students develop their understanding of the relationships between structure and function, they should begin to apply this knowledge when investigating phenomena that are unfamiliar to them. They recognize that often the first step in deciphering how a system works is to examine in detail what it is made of and the shapes of its parts.</p>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



		<p>The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. Chemical processes and properties of materials underlie many important biological and geophysical phenomena.</p>	
<p>LO1b: Generate the list of evidence needed to support a hypothesis as to why Mars is red (oxidized) and explain the importance for collecting this evidence on the macro to micro scale.</p>	<p>Planning and Carrying Out Investigations Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded.</p> <p>Constructing Explanation and Designing Solutions Offer causal explanations appropriate to their level of scientific knowledge.</p>	<p>ESS2.A: Earth Materials and Systems Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts.</p> <p>**IF USING IRON OXIDATION LAB IN CLASS TO SUPPORT THIS LESSON, THE FOLLOWING ALSO APPLY**</p> <p>PS1.B Chemical Reactions Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.</p>	<p>Patterns Different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.</p> <p>Cause and Effect: Mechanism and Prediction: Argumentation from students' own explanations of cause and effect.</p> <p>Structure and Function As students develop their understanding of the relationships between structure and function, they should begin to apply this knowledge when investigating phenomena that are unfamiliar to them. They recognize that often the first step in deciphering how a system works is to examine in detail what it is made of and the shapes of its parts.</p>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



		<p>The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. Chemical processes and properties of materials underlie many important biological and geophysical phenomena.</p>	
--	--	---	--

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



(M) Teacher Resource. Red Rocks NRC Framework Individual Activity Alignment (3 of 3)

NRC Framework Activity Alignments				
Activity	Phases of 5E Instructional Model	Science and Engineering Practices Benchmark by Grade 12	Disciplinary Core Idea Grade Band Endpoints	Crosscutting Concepts
Red Rocks Virtual Field Trip Video Intro	Engage			
Red Rocks Virtual Field Trip (Karijini and Oak Creek)	Explore	<p>Analyzing and Interpreting Data Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis.</p> <p>Planning and Carrying Out Investigations Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded.</p> <p>Constructing Explanation and Designing Solutions Offer causal explanations appropriate to their level of scientific knowledge.</p>	<p>ESS2.A: Earth Materials and Systems Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts.</p>	<p>Patterns Different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.</p> <p>Structure and Function As students develop their understanding of the relationships between structure and function, they should begin to apply this knowledge when investigating phenomena that are unfamiliar to them. They recognize that often the first step in deciphering how a system works is to examine in detail what it is made of and the shapes of its parts.</p>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



<p>OPTIONAL Iron Oxidation Lab</p>	<p>Explore</p>	<p>Analyzing and Interpreting Data Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis.</p> <p>Planning and Carrying Out Investigations Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded.</p> <p>Constructing Explanation and Designing Solutions Offer causal explanations appropriate to their level of scientific knowledge.</p>	<p>PS1.B Chemical Reactions Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.</p> <p>The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. Chemical processes and properties of materials underlie many important biological and geophysical phenomena.</p>	<p>Structure and Function As students develop their understanding of the relationships between structure and function, they should begin to apply this knowledge when investigating phenomena that are unfamiliar to them. They recognize that often the first step in deciphering how a system works is to examine in detail what it is made of and the shapes of its parts.</p>
<p>(A) Reading Rock Evidence Worksheet</p>	<p>Explore Explain</p>	<p>Analyzing and Interpreting Data Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis.</p>	<p>ESS2.A: Earth Materials and Systems Earth's systems, being dynamic and interacting, cause feedback effects that can increase or</p>	<p>Patterns Different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale</p>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



		<p>Planning and Carrying Out Investigations Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded.</p> <p>Constructing Explanation and Designing Solutions Offer causal explanations appropriate to their level of scientific knowledge.</p>	<p>decrease the original changes. A deep knowledge of how feedbacks work within and among Earth’s systems is still lacking, thus limiting scientists’ ability to predict some changes and their impacts.</p>	<p>may fail or need revision when information from smaller or larger scales is introduced.</p>
<p>Red Rocks Virtual Field Trip (Mars)</p>	<p>Elaborate</p>	<p>Analyzing and Interpreting Data Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis.</p> <p>Planning and Carrying Out Investigations Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded.</p> <p>Constructing Explanation and Designing Solutions Offer causal explanations appropriate to their level of scientific knowledge.</p>	<p>ESS2.A: Earth Materials and Systems Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth’s systems is still lacking, thus limiting scientists’ ability to predict some changes and their impacts.</p>	<p>Patterns Different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.</p> <p>Cause and Effect: Mechanism and Prediction Argumentation starting from students’ own explanations of cause and effect can help them appreciate standard scientific theories that explain the causal mechanisms in the systems under study.</p> <p>Structure and Function As students develop their understanding of the relationships</p>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University’s Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University’s Mars Education Program. The lesson and its’ associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.



				<p>between structure and function, they should begin to apply this knowledge when investigating phenomena that are unfamiliar to them. They recognize that often the first step in deciphering how a system works is to examine in detail what it is made of and the shapes of its parts.</p>
<p>(B) Red Rocks Evaluation Worksheet</p>	<p>Evaluate</p>	<p>Constructing Explanation and Designing Solutions Offer causal explanations appropriate to their level of scientific knowledge.</p> <p>Engaging in Argument from Evidence Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.</p>	<p>ESS2.A: Earth Materials and Systems Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth’s systems is still lacking, thus limiting scientists’ ability to predict some changes and their impacts.</p>	<p>Patterns Different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.</p> <p>Cause and Effect: Mechanism and Prediction Argumentation from students’ own explanations of cause and effect.</p> <p>Structure and Function As students develop their understanding of the relationships between structure and function, they should begin to apply this knowledge when investigating phenomena that are unfamiliar to them. They recognize that often the first step in deciphering how a system works is to examine in detail what it is made of and the shapes of its parts.</p>

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University’s Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University’s Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

**(N) Teacher Resource. Red Rocks NRC Framework Alignment Rubric****Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s):****NRC Framework for Science Education Alignment**

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1a: Collect geologic evidence (make observations) at a variety of scales in present day Karijini Gorge, Oak Creek Canyon, and Mars as a basis for interpretation of their present and past environments.	Generates observations for all three locations. Includes more than one observation from each of the macro-micro scales in Karijini/Oak Creek Canyon and only the macro-meso scale on Mars.	Generates observations for all three locations. Includes one observation from each of the macro-micro scales in Karijini/Oak Creek Canyon and only the macro-meso scale on Mars.	Generates observations for all three locations. Includes one observation from the macro-micro scale in Karijini/Oak Creek Canyon and only the macro-meso scale on Mars.	Generates observations.
LO1b: Generate the list of evidence needed to support a hypothesis as to why Mars is red (oxidized) and explain the importance for collecting this evidence on the macro to micro scale.	Generates list of evidence from the macro to micro scale to explain the Martian environment was/is not like Karijini or Oak Creek Canyon.	Generates list of evidence to explain the Martian environment was/is not like Karijini or Oak Creek Canyon.	Generates list of evidence to explain the Martian environment was/is like Karijini or Oak Creek Canyon.	Generates list of evidence to explain the Martian environment was/is like Karijini and Oak Creek Canyon.

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University's Mars Education Program. The lesson and its' associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.