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NASA Astronomy & Space Science
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ELEMENT	DESCRIPTION
Unit Title:	Colonizing Space
Getting Started:	<p>This unit will be an end of the year culminating activity that will conclude our space and physical science content area learning goals. This unit will further investigate the capability of human habitation on Mars and allow students to simulate a group mission to colonize Mars. Students will also be exploring the moral dilemma of transforming the barren landscape of Mars into a “New Earth.” We will be discussing human impact throughout our history of how humans have transformed Earth to how we know it as today. We will make connections discussed from the previous lesson regarding what we have learned from our mistakes on this planet and how we can potentially avoid those mistakes through advancements of science if the colonization of Mars became a reality. We will also be discussing the governing of Mars. What country or organization will be in charge? Who will be admitted to Mars: the super-rich or the healthiest of humans? What other issues could potentially arise? What are our obligations and responsibilities to the Earth/surrounding space/solar system/universe? Would we only try to colonize Mars or any other planet/celestial objects if technology allowed? We will be ending the unit with students’ predictions and rationalization for the future of the human space race.</p>
Content Area:	<p><u>Learning Goal:</u> The Challenges of Colonizing a New Celestial Object. <u>Focus Question:</u> What are the criteria and constraints for humans to live in space?</p>
Grade:	6th Grade Science
Duration:	4 Weeks- 50-minute class periods
Standards/Benchmarks:	<p>NGSS:</p> <p>MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit solutions.</p> <p>MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.</p> <p>MS-ESS3-3 Earth and Human Activity: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.</p> <p>MS-ESS3-4 Earth and Human Activity: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.</p>

	<p>MS-ETS1-2 Evaluate competing for design solution using a systematic the process to determine how well they meet the criteria and constraints of the problem.</p> <p>Common Core Standards:</p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.</p> <p>RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.</p> <p>WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.</p> <p>WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.</p>
<p>Objectives:</p>	<ul style="list-style-type: none"> • Compare physical and chemical compositions between Earth and Mars. • Use aerial imagery to make observations and inferences about Mars. • Build connections between student’s prior knowledge European exploration and colonization of America and colonization of Mars. • Students begin to consider advantages and disadvantages to space travel and habitation. • Students consider potential challenges pertaining to habitation on another celestial body. • Hypothesize potential problems that they may face as humans explore habitation outside of Earth. • Obtain, evaluate, and communicate information about the similarities and differences between Mars and Earth. • Students discuss the pros and cons of living in space and construct an evidence-based argument for or against long-duration habitation using claims, evidence, and reasoning. • Make a claim for or against human habitation in space using supporting evidence and reasoning. • Students focus on supporting life during long-duration habitation and begin designing possible solutions that take into consideration the criteria and constraints that survival will depend upon.
<p>Pre-Assessment/ Activating Background Knowledge</p>	<p>Prior to this unit, students will have explored all the planets in our solar system including the physical conditions, chemical compositions, distances from Earth/Sun, and any extreme phenomena of the planets. As a summative assessment to space and physical science content goals, students will be using their prior knowledge and collected data in their interactive notebook to write an argumentative essay on which celestial object in our solar system they believe would be the best option for human colonization based on previous research and data collection. They will be given the writing prompt: “You are now an expert space scientist. You have been selected by NASA to make the decision on which planet you believe would be best suited for human habitation and to colonization. Based on your previous research, present NASA with your decision supported with evidence and reasons for your decision.”</p>

Assessment/ Data Collection	<p>Formative Assessments: Vocabulary Pre-Unit Test, Comparing Earth & Mars T-Chart, Claim-Evidence-Reason (CER) Pros & Cons of Long-Duration Space Habitation. Class Debate: For or Against Colonizing Mars.</p> <p>Performance Assessment: Group “Mars Colony Design Project” Rubric.</p> <p>Summative Assessment: Vocabulary Post-Unit Test, Personal Reflection Writing Artifact: minimum of one-page argumentative essay expressing student’s viewpoint for or against the long-duration human habitation of Mars or any other future colonization of celestial objects outside of Earth.</p>
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Daily Lessons and Activities: 5e Unit

Engage	Two Class Periods
<p>Preparing for Lesson & Differentiation:</p>	<p>-Students will need their interactive notebook to take notes on observations of Mars.</p> <p>-Remind students that the images are actual images and not computer generated.</p> <p>-Review qualitative data observations with students and model for class an example. Students with IEP’s can be supplied with a starter list of examples.</p> <p>-To create the Venn Diagram in their notebooks, students will need protractors to be able to create neatly. To assist struggling students, create thin cardboard traceable circles that are 8” and 4” in diameter.</p>
<p>Standards- MS-ESS2-2, RST.6-8.1, RST.6-8.9</p> <p>Essential Question: How are Mars and Earth the same and different?</p>	<p>Learning Goals:</p> <ul style="list-style-type: none"> • Compare physical and chemical compositions between Earth and Mars. • Use aerial imagery to make observations and inferences about Mars. • Build connections between student’s prior knowledge European exploration and colonization of America and colonization of Mars. <p>Sol 1-2: Introduction to Unit and Comparing Mars and Earth</p> <p>Sol 1: Introduce the unit by declaring that your students have been selected by NASA to be the first humans to inhabit the planet of Mars. Introduce and have student’s read aloud NASA’s Journey to Mars Challenge, and show the short video clips of “Buzz Aldrin Mars Mission” and “NASA Dreams of Boot prints on Mars” included in NASA’s Journey to Mars Challenge Website. Show NASA’s Mars as Art Slideshow. Describe as the next frontier (clarify the meaning of frontier).</p> <p>Think/Pair/Share observations of Mars.</p> <ul style="list-style-type: none"> • Think: On the interactive whiteboard, display Google Mars and ask students to go to Google Mars on their Chromebooks. Instruct to explore the surface of Mars and write down as many descriptive words that come to mind as you explore the aerial photography. • Pair: Have pairs of students discuss their descriptive words, add any of your partner's words to your list that you thought were accurate words that you did not think of. • Share: Create a Word Cloud using PollEverywhere and capture screenshot of class descriptive words. Invite pairs to share their observations. <p>Exit Ticket: Class Survey “Would you volunteer to be a Mars pioneer?” + Research 1 Interesting Fact.</p> <ul style="list-style-type: none"> • Pass out Exit Tickets. Have students check Yes, they would volunteer to go to Mars, No, they would not, or Undecided. Have students research one interesting fact they did not know about Mars and two challenges they would face colonizing Mars.

	<p>Sol 2: Create a class survey of the percentage of students that would be willing to go to Mars (briefly discuss why). Ask for volunteers to share interesting facts they found that they wrote on Exit Tickets (10 minutes).</p> <p>Class KWL Chart</p> <ul style="list-style-type: none"> • Create a class KWL Chart of prior knowledge of students, explore what students want to know about Mars, and brainstorm ways they can learn more about Mars. <p>Venn Diagram Using Scale Drawings of Earth and Mars</p> <ul style="list-style-type: none"> • Students will be further investigating Mars and Earth using internet searches and books. Students will be organizing research using traditional Venn Diagrams in a new format. First Students will determine the scale dimensions of Earth’s diameter to fit onto a piece of paper: 1,000 miles=1 inches. Draw a circle to represent Earth (8 inches), then draw an inner circle to represent the size of Mars (4 inches). Inside the smaller Mars circle, students will write previous knowledge and data collected on Mars in the Mars circle. They will put their data of Earth in the bigger outer circle representing Earth. In the space surrounding the circles, students will write down all similarities they found of the characteristics the two planets share.
<p>Explore</p>	<p>Five Class Periods</p>
<p>Preparing for Lesson & Differentiation:</p>	<p>-Remind students of what misconceptions are and history of why we often associate aliens as Martians. Optional: discuss War of the Worlds radio broadcast or sci-fi movies.</p> <p>-Ask students if living on Earth is considered living in space? What is the difference between Earth and other celestial objects (habitable zone)?</p> <p>-T-Chart Differentiation: Students that are struggling writers can be provided with a list of examples and leave 3 blank spaces to fill-in instead of an entire list. This may prompt those students to participate and drive construction of chart.</p> <p>-Groups can be assigned or allow students to select partners depending on class. Assign students that are challenged with group collaboration accordingly, or students that struggle to be organized with a peer partner.</p> <p>-Remind groups they will have 3 working class periods to complete the project. It is important to assign jobs and stay on task. Depending on the class, jobs or student outcomes/project goals can be assigned or altered to meet the needs of students.</p> <p>-Provide groups with peer-evaluation sheets/project rubric prior to the project to ensure expectations are clarified.</p> <p>-Depending on available time, modifications can be made to goals of the project or extended to include mathematical calculations of time to travel to Mars or have groups predict launch windows according to celestial orbits.</p>
<p>Standards-MS-ETS 1-1, MS-ESS3-3, RST.6-8.1, RST.6-8.9, WHST.6-8.7</p> <p>Essential Question: Why would we choose to attempt to inhabit Mars instead of the Moon or other</p>	<p><u>Learning Goals:</u></p> <ul style="list-style-type: none"> • Students begin to consider advantages and disadvantages to space travel and habitation. • Students consider potential challenges pertaining to habitation on another celestial body. • Hypothesize potential problems that they may face as humans explore habitation outside of Earth. • Obtain, evaluate, and communicate information about the similarities and differences between Mars and Earth.

<p>planets?</p> <p>Focus Question of Group Project: Why are the conditions of Mars not as conducive to life as Earth's environment?</p>	<p>Sol 3-8: Class Discussion, Research, Group Project</p> <p>Sol 3-4: Discuss misconceptions, background, and history of Mars exploration (NASA Mars Exploration Website).</p> <ul style="list-style-type: none"> Analyze and summarize characteristics using "Earth vs. Mars" and fill in Mars and Earth T-Chart. Include atmosphere, land features, gravity, access to water, and natural disasters of the two planets. <p>Sol 5-8: Start Mars Colony Project. Assign or allow students to create groups of 3-4. Group will decide to create a written report, oral presentation, poster, video, slideshow, or any other creative pre-approved method of delivery for their research.</p> <p>Mars Colony Design Project: Project will be Due and Presented on Sol 12.</p> <p>Assign students into groups of 4, and delegate the following roles to students. Consider the needs of students to ensure equity when assigning responsibilities. Explain the significance of each role of the student within their group to function as a team.</p> <ol style="list-style-type: none"> 1) Presenter and Teacher Liaison. 2) Recorder and Researcher. 3) Artist and Materials Manager. 4) Friendly Critic and Organizer. <p>Goals of Project:</p> <ol style="list-style-type: none"> 1) Create a flight plan you will use to complete your mission. You may choose to select any method of the project to display your gathered information. Be sure to include the duration of travel, calculate the amount of food and water you will need for survival, and create a list of materials/tools/supplies you would find useful on your journey. Be sure to focus and investigate issues that may arise personally and within your community. Investigate issues such as food production, safety, health, transportation, and environmental conditions. 2) Have students survey and research Mars surface and select a location for their new colony. Be sure to document and include the geographic location of a new colony on a map. Either electronically or hand draw an architectural layout of the new city. Be sure to give the colony a name and label structures with descriptions.
<p>Explain</p> <p>Preparing for Lesson & Differentiation:</p>	<p>Three Class Periods</p> <p>-Hand out a copy of "Living and Working in Space" to students. While reading this article, have students color code reading with one color highlighter for any information they included in their flight plan and one color for criteria they may have not considered.</p> <p>-Students that have trouble following along and highlighting for analyzing details can work with a group partner to help follow along.</p> <p>-Clearly define expectations of class debate rules (allow students to state opinion and evidence, don't interrupt, arguments must be factual and not emotional, etc.)</p> <p>-For class debate, assist students that need support researching information and allow those students to start the debate. This will get the debate started with good points of conversation, help build confidence in those students, and challenge other students with coming up with arguments that may have already been given.</p> <p>-Create guided questions for Content Media section to help guide students.</p>

<p>Standards- MS-ESS3-4, RST.6-8.1</p> <p>Essential Questions: Are there moral dilemmas to consider before colonizing another planet?</p> <p>What connections can be made between Earth and Mars when compared to European exploration and settlement of America?</p>	<p>Learning Goals:</p> <ul style="list-style-type: none"> • Students discuss the pros and cons of living in space and construct an evidence-based argument for or against long-duration habitation using claims, evidence, and reasoning. • Make a claim for or against human habitation in space using supporting evidence and reasoning. • Introduce Key Vocabulary Terms: Rover, surface gravity, weight, and long-duration habitation. <p>Sol 9-11: Further Investigation of Long-Duration Space Habitation</p> <p>Sol 9: Read Aloud NASA’s “Living and Working in Space”: After the reading, facilitate discussion of the accuracy of the student’s flight plans in comparison to this article. Were there any considerations that were included in the article that you did not think of? Define criteria and constraints that a civilization must include ensuring survival.</p> <p>Sol 10: Class Debate Divide the class into two large groups. Assign one group to be for Mars habitation, and the other group to be against Mars habitation. Provide the following guiding questions and give groups 15 minutes to research and create their arguments: Why should we even consider living in space? Who should be able to go there (Rich, Healthy, Lottery System)? Who should pay for the space travel and habitation (United States, Global Organization, Private Organization)? Would the money be better spent here on Earth? How should we learn from our mistake’s humans have made on Earth? What are our future obligations to Earth, our Solar System, and Galaxy? Are we the protectors of or intruders of our universe? -Be sure to act as a facilitator for discussion. Provide rules of debate prior to and use guiding questions as prompts. Provide each student a ticket to fill out for the main idea of their debate. Make sure all students speak, collect ticket after student speaks to ensure all students have had a chance. Take notes for formative assessment.</p> <p>Sol 11: Content Media: Watch “Mars Making the New Earth Documentary” -Reflection Question: Why do they refer to Mars as “New Earth?”</p>
<p>Elaborate</p>	<p>Seven Class Periods</p>
<p>Preparing for Lesson & Differentiation:</p>	<p>-Timeline Differentiation: give struggling students a timeline with missions already listed and have those students fill in accomplishments/failures of the mission.</p> <p>-Discuss Group Presentations/Reflections Rubric prior to presentation to allow students to be prepared. Help struggling student with helping them prepare a script or notecards to read from.</p> <p>-For STEAM Project, this is an optional part of the unit and can be differentiated modified depending on time/resources for the project. Or one component of the project can be done as a class or can be voted on by the class to streamline activity.</p> <p>-Guided STEAM activities can also be supplied to struggling students for accommodation, however, struggling students often excel with this option.</p>
<p>Standards- MS-ETS1-2, WHST.6-8.7</p>	<p>Learning Goals:</p> <ul style="list-style-type: none"> • Students focus on supporting life during long-duration habitation and begin designing possible solutions that take into consideration the criteria and constraints

<p>Essential Questions: What technological advances have NASA already discovered that makes the idea of colonizing Mars possible?</p> <p>What challenges does NASA still face that would need to be solved or that could possibly make colonization impossible without further technological advancement?</p>	<p>that survival will depend upon.</p> <p>Sol 11-18: Further Investigation of Long-Duration Space Habitation</p> <p>Sol 11: Mars Exploration Timeline As a class, have the students create a timeline for past events that have occurred on Mars and projected future timelines from the research of NASA, Space X, and other credible sources. List mission name, the goal of the mission, and accomplishments or failures of the mission). Use Resource: NASA’s Mission to Mars Historical Log.</p> <p>Sol 12-13: Group Presentations/Reflections From your research, Mars and Earth have many of the same planetary processes. From your Mars Colony Design Project, how will the differences in gravity, magnetic field, or natural disaster/resources affect the success of habitation? What are the most important aspects should humans consider when designing colonies on Mars?</p> <p>Sol 13-18: STEAM Engineering Project Based-Learning With a partner, select one of the following STEM projects to complete:</p> <ol style="list-style-type: none"> 1) A 3-Dimensional version of your Mars Colony. 2) Construct a NASA Mars Rover 3) Code a Mars game or educational resource using Scratch. 4) Design a Mars space suit. 5) Invent a new piece of technology that everyone on Mars will need. 6) Think of your own project and get it approved.
<p>Evaluate</p>	<p>Two Class Periods</p>
<p>Preparing for Lesson & Differentiation:</p>	<p>-Students with writing IEP’s can have the option of verbally explaining their argument for or against the colonization of Mars or can be required to only complete the CER outline that is modified for individual students needs. The goal of summative assessment is to evaluate the technological constraints, the challenges for survival and resources, and the moral issues that face future colonization of planets.</p> <p>-Inform students and parents there is explicit language and adult content in the movie “The Martian,” however it is an accurate depiction of the challenges that humans could potentially face while colonizing Mars and demonstrates human capabilities of using STEM to problem solve.</p>
<p>Standards-RST.6-8.1, WHST.6-8.9</p> <p>Essential Question: Has your viewpoint of whether Mars should or should not be colonized changed because of moral issues or the technological challenges of colonizing in space?</p>	<p>Learning Goal:</p> <ul style="list-style-type: none"> • Students demonstrate an understanding of exploration and habitation of space. <p>Sol 19-20: Summative Assessment/Reflective Writing Artifact: Students will use the information they have gathered from this unit and reflect whether their viewpoints of long-duration habitation have changed or stayed the same. Have students create a Claim, Evidence, and Reasoning Outline to help develop a minimum of one-page argumentative essay expressing your viewpoint for or against the long-duration human habitation of Mars or any other future colonization of celestial objects outside of Earth.</p> <ul style="list-style-type: none"> • Watch “The Martian” (2015) Movie. PG-13 Movie (will need parental permission).
<p>Summary/Reflection</p>	<p>I am excited that this is the first year that I can teach Space Exploration at my new school to the 6th grade. I am also launching a STEAM Fair at my school for the first time and I hope this unit is a continuation of some interests my students may have discovered through this learning experience. I was able to integrate a Mission to Mars</p>

Unit at my last school for the 8th grade STEM class, but this will be my first attempt with 6th graders. Challenges I face are to convince my PLC team of ending the year with this student-centered and project-based learning unit instead of the learning kit that they have been using for the past years. Since many of the lessons align with the activities provided with our book and lab kits, I am hoping to sell this unit as a supplementary learning unit for teachers to use and they can utilize it if they choose. I have made sure that the same standards are being covered except they are supported by NASA resources. I believe the energy level of students at the end of the school year can be harnessed by many of the hands-on and collaborative projects included in this unit. There are many opportunities within the lessons for differentiation and accommodations to meet the needs of all struggling students as well as room for high performing students to be challenged to go above and beyond. Time management, classroom management, and teacher preparation will be key for this unit to be completed and engaging. I believe this unit's flow from one activity to the next will be smooth and will scaffold learning from previous lessons and allow students to be able to make connections and predictions to the path of future space exploration. One additional challenge for me is to fit all the activities in at the end of the year. The provided unit allows for two weeks and I am accounting for this unit to cover a total of four weeks. I am considering what lessons leading up to this unit can also be incorporated or streamlined. A key attention grabber for this lesson is that students in my classes could potentially be future Martians and be the first generation to inhabit a planet other than Earth. It is my hope that this possibility will capture the imaginations of my students, to problem solve by thinking outside the box, and to promote the endless possibilities that advancements in science and technology can lead us to.

Materials/Sources:
 -Chromebooks
 -Handouts
 -Readings
 -Materials for projects will be collected from home, makers space, surplus science supplies, or created in conjunction with the tech-ed teacher.

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