Challenger Learning Center of Northern Nevada **Spring 2016**
NASA-Based Mars Mission (Three-Hour Capstone Lesson) Review draft
Versions Appropriate for 5th-Grade through College-Age Learners and Professional Groups

Objectives:
All students will represent NASA professionals; perform experiments; use communication skills and technology to share, analyze and interpret data; solve problems collaboratively; and maintain a healthy closed-loop environment for life support while the engineers build and test a probe to launch to one of the two moons of Mars.

The Mars Mission incorporates all six of the **21st Century Competencies**,
integrates crucial **Next Generation Science and Engineering Practices**,
aligns with specific **NGSS Disciplinary Core Ideas** and **Crosscutting Concepts**,
employs all 21 of the **CTE Workplace Readiness Skills,**
and requires students to practice Anchor Standards for College and Career Readiness
of the **Common Core/Nevada Academic Content Standards in English Language Arts**
and **Mathematics** and develop and apply **team building skills**
while also providing opportunities for students to explore college and career pathways
in **Science, Technology, Engineering and Math**
(in fact, Challenger Center for Space Science Education was the first nationwide organization
to emphasize STEM as an educational focus for American K-12 students).
See attached standards sheets and 21st Century templates for specific examples.

By performing the mission activities, students also have the opportunity to engage in real-world activities designed by NASA subject matter experts (SMEs) and local and national professionals in the following **CTE Industries**: Agriculture & Natural Resources; Arts, Media & Entertainment; Energy, Environment & Utilities; Engineering & Architecture; Health Science & Medical Technology; Information & Communication Technologies; Transportation. (See chart.)

Mission Activity Plan

Prior to the Lesson:
- Teachers provide instruction and practice in skills needed to succeed as citizen scientists
- Teachers provide job applications for students to apply for crew positions on a NASA mission
- Class completes labs/activities to prepare and practice for their capstone mission as a team
- Class designs a Mission Patch to represent their efforts, objectives and identity as a crew
- Teacher utilizes multimedia (e.g., *Journey to Space*) to provide background for students

During the Lesson/Mission:
- Set Induction: Students participate in Mission Briefing about their destination and objectives
- Spacecraft: Students perform hands-on experiments and communicate data to colleagues
- Mission Control: Students research, analyze and interpret data relating to the Mission

Mid-Mission:
- Teacher/Flight Director briefs students regarding the second half of their mission
- Students converse with their colleagues about their roles and research
- Students switch roles with their Mission Control or Spacecraft counterparts

Post-Mission:
- Students engage in metacognition to reflect on the skills and activities employed during their mission and discuss how these relate to potential college and career pathways
- Teachers continue with lessons/activities related to student mission goals & career pathways

Authentic Assessment:

- Teachers and students review their performance via their data logs and through teacher and/or media-documented observations
- Students and teachers also have authentic products of their mission, including the engineering probe and circuits, completed experiment results and successful mission accomplishments by individuals and the team as a whole

WCSD 21st Century Learning Competency*	Mission Activity
Collaboration	Students work with a partner and teammates to gather information, discuss challenges, make decisions, solve problems, carry out solutions and combine components of each pair's work for a successful mission outcome.
Knowledge Construction	Students perform experiments to generate and communicate data; and research, analyze and interpret data to build products, solve problems and accomplish mission objectives.
Real-World Problem Solving & Innovation	Students develop innovative technology and teamwork to solve engineering and science problems and simulated emergencies in real-world, NASA-based missions.
Use of Technology for Learning	Students effectively use computers, coding, oximeters and other real and virtual technologies to perform experiments, create media, form solutions and build science equipment.
Self-Regulation	Students work independently and collaboratively, managing projects and being responsible to each other to complete projects within mission timeframes.
Skilled-Communication	Students must communicate clearly in and across simulators to collaborate with teammates face-to-face and using headsets, email and video.

*See additional templates for more details about elevator levels, standards and specific activities.

Next Generation Science and Engineering Practices*

4. Analyzing and interpreting data	While working in Mars Control, students are responsible for recording, analyzing, and interpreting the data that they are given by their teammates in the Mars Transport Vehicle.
5. Using mathematics and computational thinking	Students record, calculate and analyze data based on measurements from science instruments, experiments and engineering projects.
6. Constructing explanations (for science) and designing solutions (for engineering)	Students in Mars Control must use the information and data they are given by their teammates in the Mars Transport Vehicle to construct an argument based on the information they are presented with.
8. Obtaining, evaluating, and communicating information	While students are in the Mars Transport Vehicle/Spacecraft, they obtain information and data and must communicate this information to Mars Mission Control.

*See additional pages for specific Next Generation Standards Disciplinary Core Ideas.

Challenger Center *Voyage to Mars* Standards Alignment
Nevada Academic Content Standards/Common Core

Reading	**Informational Text**
RI.6-8.7: Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.	Students read from task cards, computers and iPads, using charts, images and videos to understand topics related to their crew position (e.g., Life Support, Medical Issues, Engineering).
Writing	**and Researching**
W.6-8.2d: Use precise language and domain-specific vocabulary to inform about the topic. **W.6-8.2e:** Establish and maintain a formal style. **W.6-8.7:** Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate. **W.6-8.9b:** Draw evidence from informational texts to support analysis, reflection, and research.	Students write messages to their team mates in Mission Control or Spacecraft using scientific terms to inform them about experiment results using a style appropriate for NASA missions; conduct both research and hands-on experiments to answer critical mission questions; and draw evidence from data sources and team mates to support their analysis and reflection.
Speaking	**and Listening**
SL.6-8.1: Engage effectively in a range of collaborative discussions...building on others' ideas and expressing their own.	Students engage in communication and problem solving with team mates in order to successfully accomplish mission objectives.
SL.6-8.1c: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.	Students use microphones, headsets and video cameras to ask and answer questions of their team mates as they make projects, solve problems and perform experiments.
SL.6-.6: Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.	Students communicate with teammates, Flight Director and Mission Commander across simulators using formal NASA-based protocol.
Literacy in	**History/Science/Technical Subjects**
RH.6-8.7: Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.	Students read, assimilate and utilize information gathered from maps, videos and print and digital text sources and compile data in charts.
RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.	Students perform detailed science experiments and build multicomponent engineering projects by following precise multistep procedures.
RST.6-8.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to…texts and topics.	Students encounter, interpret and utilize scientific terms from a variety of disciplines — e.g., astronomy, biology, chemistry, geology and physical science — as they relate to the mission.
College and Career	**Readiness Anchor**
R.10: Read and comprehend complex… informational texts independently and proficiently.	Students demonstrate their understanding of texts by successfully performing the directions in them.

Challenger Center *Voyage to Mars* Standards Alignment
Nevada Academic Content Standards/Common Core

Mathematics	The Number System
M.6.NS.B.2: Fluently divide multi-digit numbers using the standard algorithm. **6.NS.B.3:** Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.	Students record data, add and divide readings to calculate the average, and evaluate readings from science instruments in decimal formats.
Mathematics	**Expressions & Equations**
6.EE.B.8: Write an inequality of the form x > c or x < c to represent a constraint or condition in a real-world or mathematical problem. Represent solutions on number line diagrams.	Students evaluate variables on the spacecraft to determine if readings are within acceptable parameters, plotting readings on a number line as a technique for analysis.
Mathematics	**Statistics & Probability**
6.SP.5: Summarize numerical data sets in relation to context.	Students analyze numerical data in order to determine if results are within acceptable range.

Note: Students use math at a variety of levels, reviewing skills from earlier grades and being introduced to advanced functions; additional sample tasks include plotting coordinates, determining mass and volume, altering orbits and triangulating position by measuring angles and using elements of trigonometry.

Nevada Academic Content Standards/Next Generation Science Standards

Disciplinary Core Ideas	Mission Activity
Motion and Stability: Forces and Interactions: MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.	Students use computer simulations to investigate and obtain evidence to determine the appropriate angle to fire retrorockets to change the motion of the spacecraft/mass and re-direct it into a stable orbit around Mars.
From Molecules to Organisms: Structures and Processes: MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	Students conduct food crop surveys and research to determine appropriate species to grow on Mars based on nutrition and yield, and, in advanced groups, evaluate light, water, temperature and fertilizer on the growth of plants.
MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	Students perform experiments to determine visual and auditory reaction time of crew members to evaluate overall health and potential presence of hypoxia, if responses are outside parameters.
Earth's Place in the Universe: MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system. **Earth and Human Activities: MS-ESS3-2.** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate effects.	Students use their knowledge about Mars and the solar system to transport a crew of astronauts to Mars and safely return a crew to Earth. Students must launch one or more probes to Mars' moons. They must also conduct research about hazards (e.g., micrometeorites and radiation) and work to keep the crew safe.

Challenger Center *Voyage to Mars* Standards Alignment

Nevada Academic Content Standards/Next Generation Science Standards

Crosscutting Concepts	**Mission Activity**
2. Cause and effect	Students handle a variety of emergencies caused by anomalies. Students must solve the emergency or abort the mission.
3. Scale, proportion and quantity	Students use beakers, graduated cylinders, a Geiger counter, balances, etc. to perform experiments and monitor environments on the Mars Transport Vehicle.
6. Structure and function	Students build probes to launch to Mars' moons.
Nature of Science	**Mission Activity**
1. Scientific Investigations Use a Variety of Models 2. Scientific Knowledge is Based on Empirical Evidence	Students employ models of the solar system and use scientific instruments, lab equipment, science process skills and techniques to complete hands-on activities and observations.
5. Science as a Way of Knowing	Students make measurements, record observations and analyze data to contribute to their role in the mission.
7. Science as a Human Endeavor	Students take on the role of scientists, engineers, flight controllers and astronauts on the mission.

Sampling of STEM professionals engaged in designing and conducting Challenger Center for Space Science Missions with Partners from NASA, NOAA and international STEM organizations

Aerospace Engineers
Agricultural Scientists and Botanists
Astronomers and Astrophysicists
Atmospheric Scientists
Biologists and Microbiologists
Chemists
Climatologists
Computer Scientists
Educators (Art, ELA, Math, Science)
Electrical Engineers
Flight Controllers
Flight Surgeons
Geologists and Geophysicists
HazMat Technicians
Hydrologists
Mechanical Engineers
Meteorologists
Nutritionists
Physicians
Planetary Scientists

Alignment with CTE Industries

CTE Industry	Student Crew Position(s)	Lesson/Mission Activities	College Disciplines or Certificates	Challenger Team and Advisors*
Agriculture & Natural Resources	Life Support Officers and REM Team Geologists and Planetary Scientists	Perform food survey and research plants. Characterize and analyze rock and soil samples. Identify minerals. Check tap water for pH and total dissolved solids. Evaluate oxygen systems. Analyze data. Problem solve emergencies. Read and interpret scientific gauges including Hygrometer, Barometer, Thermometer, Ammeter. Experiment on soil for signs of microbial life.	Agriculture, Biology, Engineering, Geology, Hydrology, Mining	Dr. Richard Simmonds; Dr. Wendy Calvin
Arts, Media & Entertainment	Public Relations Officers	Perform interviews. Gather information. Take photos. Shoot, edit and produce a multimedia video.	Digital Media and Journalism	Paul McFarlane
Energy, Environment & Utilities	ISO and Life Support Officers	Operate robotic arms. Measure mass of liquids. Evaluate micrometeorite strike panels and determine hazardous conditions. Use a Geiger Counter remotely to measure filters for appropriate radiation levels. Communicate, analyze and interpret data. Solve emergencies. Evaluate solar panels for levels of energy generation.	Environmental Science and Solar Energy Programs	Meghan Collins; Brian Fitzgerald
Engineering & Architecture	Probe Team Engineers	Research and build an aerospace probe for NASA. Mass and evaluate components. Assemble a mother board. Test circuits and solve problems with faulty systems.	Aerospace and Mechanical Engineering	Dee Frewert; Jim Nichols
Health Science & Medical Technology	Flight Surgeons and Medical Technicians	Determine visual and auditory reaction times to evaluate human health and presence of hypoxia. Measure and evaluate temperature. Determine resting and active blood pressure to do a comparative study. Measure oxygen saturation using pulse oximetry. Diagnose and perform procedures and surgery on virtual patients.	Aerospace Medicine, Medical and Nursing Professions	Dr. Steve McFarlane; Dr. Owen Peck
Information & Communication Technologies	Data and COM Officers	Evaluate, prioritize and transmit data, using communication skills. Practice team leadership skills. Chart and track weather systems. Program/code a rover for use on a planetary surface.	Computer Science; Communications & IT	Eric Henry
Transportation	Pilot and Navigators	Launch, dock and land spacecraft on Mars and Earth. Identify constellations. Measure angular diameter. Triangulate position. Calculate angle for firing retrorockets to perform orbital insertion. Plot course.	Pilot certification; navigational certification	Richard Brong

***See bios and list of Nevada's Challenger Center Team Members.**

Challenger Learning Center of Northern Nevada Mission Simulations and Employability Skills for Career Readiness

Challenger Center missions are designed and updated by actual professionals from NASA (scientists, engineers, astronauts and flight surgeons) working in conjunction with educators around the country.

These missions are meant to provide participants (both students and adult professionals) with an engaging and realistic experience of what it is like to work in and for NASA.

In a context that cannot be provided in most school classrooms, the Challenger Center environment provides technology and scenarios that replicate and represent an actual work situation — from applying for a job all the way through successful completion of that job.

In this very specially-equipped "classroom," the Mission Control and Spacecraft modules put students to the test, allowing them to integrate, practice and apply:

Common Core/Nevada Academic Content Standards in ELA and mathematics
Next Generation Science Standards
and Workplace Readiness Skills

In fact, because this is a workplace environment (complete with actual science and engineering equipment and communication technologies), participants engage in all **21 CTE Employability Skills**. (See list of skills with connections to the mission.)

Here are eight specific examples of skills applied and documented during each and every mission:

#14. Job Application and Advancement
Students are expected to complete a job application as a means for being assigned to their crew positions.

#4. Self-Representation
Students put on their crew uniforms and security badges to represent their team and NASA, as well as specific appropriate items such as lab coats in the Clean Room and smocks any goggles at the Life Support water testing station.

#3. Teamwork
Students must engage in teamwork throughout the mission with a partner, their counterparts in Mission Control or the Spacecraft, and with the entire team as a whole in order to complete their jobs successfully.

#8. Speaking and Listening, **#9. Reading and Writing** and **#16. Mathematics**
Students must read about the importance of their jobs and follow precise vocationally-related instructional texts (NASA-style task cards) to perform their work duties during the mission, write emails to teammates and speak and listen to directions over headsets and microphones. In addition, students are gathering and communicating data, and performing a variety of math tasks including averaging numbers, using decimals, measuring mass and angles and plotting coordinates.

18. Job Specific Technologies and **21. Telecommunications**
Students must use specific and real workplace technologies such as pulse oximeters and Geiger Counters, and with a professional network server they use headsets, microphones, email, printers and video cameras to communicate remotely between ground control and the spacecraft simulator.

CTE Workplace Readiness Skills (Employability Skills for Career Readiness)
related to and demonstrated in Challenger Center missions—observed directly and over camera system and documented in data logs during NASA-based team simulations

Personal Qualities and People Skills

1. **POSITIVE WORK ETHIC:**
   Comes on time, meets mission deadlines, takes directions from Flight Director and Mission Commander and is motivated to accomplish mission tasks
2. **INTEGRITY:**
   Abides by NASA/program policies and demonstrates honesty and reliability in their duties
3. **TEAMWORK:**
   Contributes to the success of the team, assists others and requests help when needed
4. **SELF-REPRESENTATION:**
   Dresses appropriately in team uniform and uses language and manners suitable for NASA
5. **DIVERSITY AWARENESS:**
   Works well with all coworkers, adults, observers and Mission Control Team members
6. **CONFLICT RESOLUTION:**
   Negotiates diplomatic solutions to workplace issues that arise during mission
7. **CREATIVITY AND RESOURCEFULNESS:**
   Contributes new ideas and works with initiative to accomplish mission goals

Professional Knowledge and Skills

8. **SPEAKING AND LISTENING:**
   Follows directions and communicates effectively with teammates
9. **READING AND WRITING:**
   Reads and interprets workplace documents (e.g., task cards) and writes clearly in mission emails
10. **CRITICAL THINKING AND PROBLEM SOLVING:**
    Analyzes and resolves problems that arise in completing assigned tasks
11. **HEALTH AND SAFETY:**
    Follows safety guidelines (especially re: hazards) and manages personal health (MED team)
12. **ORGANIZATIONS, SYSTEMS AND CLIMATES:**
    Identifies big picture (overall mission objectives) and individual role in fulfilling the workplace mission
13. **LIFELONG LEARNING:**
    Learns new industry-related information and improves professional and science process skills
14. **JOB ACQUISITION AND ADVANCEMENT:**
    Prepares a job application for team leader to seek promotion to official NASA crew positions
15. **TIME, TASK AND RESOURCE MANAGEMENT:**
    Organizes and implements a productive plan of work to accomplish goals during mission
16. **MATHEMATICS:**
    Uses mathematical reasoning to accomplish tasks
17. **CUSTOMER SERVICE (note: customers are NASA directors, taxpayers and team members)**
    Identifies and addresses needs, providing helpful, courteous, knowledgeable service

Technology Knowledge and Skills

18. **JOB-SPECIFIC TECHNOLOGIES:**
    Selects and safely uses technological resources to accomplish work responsibilities productively
19. **INFORMATION TECHNOLOGY:**
    Uses computers, file management techniques, and software/programs effectively
20. **INTERNET USE AND SECURITY:**
    Uses the internet appropriately for mission tasks (e.g., researching mission experiments)
21. **TELECOMMUNICATIONS:**
    Selects and uses appropriate devices, services and applications (e.g., headsets, mikes, iChat, email)

21st Century Learning and NASA-Based Challenger Missions: Collaboration

Element	What students do	Result
Students' work is interdependent	Students must work with their partner and the members of other teams in Mission Control and spacecraft to provide information, discuss challenges, make decisions, solve problems, carry out solutions and contribute products of their activities, the components of each pair's work combining to form a successful mission outcome.	The final learning product cannot be completed without the individual and group accountability and participation of ALL team members
+ Students make substantive decisions together	Students work with their partner (both in Mission Control and spacecraft) to make critical decisions about simulated life-and-death challenges together.	Students make collaborative decisions about how to perform experiments and solve problems.
+ Students have shared responsibility	Students work in pairs and with the rest of the crew to accomplish the overall mission objectives, build the probe and successfully accomplish their NASA-based mission challenges.	Students work together on the same product of learning, and the mission depends on all team members sharing responsibility for the outcome.
+ Students are required to work in pairs or groups	Students work with their speciality team partners and with the larger group to solve problems, perform experiments and use technologies.	Students engage in formative feedback with their partners and are required to work in pairs and with other members of the interdisciplinary team

STUDENTS are collaborating when they work in pairs or groups to discuss an issue, solve a problem and/or create a product

Collaboration

Activity:

Students will work in pairs and with members of other teams in both Mission Control and the spacecraft to perform experiments; communicate, analyze and interpret data; discuss challenges, solve problems and create solutions in the form of procedures and technology applications.

Standards:

CCSS-ELA-SL.6/7/8.6:Adapt speech to a variety of contexts and tasks

CCSS-Math-6.NS.6: Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes...with negative number coordinates.

Next Generation SS-MS.ESS3.2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

Challenger Learning Center Northern Nevada

with input from team members with College of Science, UNR Desert Research Institute Pathways to Aviation TMCC and...

National Automobile Museum

WCSD 21st Century Learning

Sample Members of Nevada's Challenger Center Educational Team

<u>Dr. Wendy Calvin, Planetary Science</u>
Dr. Calvin is a Professor and the Chair of Geological Sciences and Engineering in the Mackay School of Earth Sciences and Engineering. She serves on the NASA Mars Exploration Rover Science Team and on the committee charged with determining where NASA should explore in the next decade. Her scientific discoveries have included identifying oxygen on Ganymede, large path lengths in ice for the seasonal polar cap of Mars, and identification of ammonia ices on Pluto's satellite Charon. She continues to work with three active science instruments at Mars and is also the Director of the Great Basin Center for Geothermal Energy.

<u>Paul McFarlane, Media and Technology</u>
Herz Gold Medal Winner and Best of Education Recipient from the *Reno Gazette-Journal*, McFarlane was selected as Outstanding Student Teacher at UNR and as the Senior Scholar for the College of Arts and Sciences. He's taught K-College students for 24 years, created interdisciplinary space programs and worked as a writer and director of video projects. He's trained at the Kennedy Space Center, Johnson Space Center and the US Space and Rocket Center and has represented Nevada at Honeywell Educators@Space Academy. He's been in charge of Challenger Center space science programs for Nevada for the last eight years.

<u>Dr. Melodi Rodrigue, Astronomy and Astrophysics</u>
Dr. Rodrigue did her doctoral research in the area of interacting galaxies, using such tools as the Hubble Space Telescope and the International Ultraviolet Explorer. Currently she teaches in the UNR Department of Physics and is respected for her ability to make courses relevant for introductory-level students and non-science students -- as well as her gift for working with a wide range of learners of all ages. Rodrigue serves on the K-12 Northern Nevada Science Coalition, helped develop the UTeach program and Astronomical Measurements course at UNR and established the MacLean Observatory for students and fellow researchers.

<u>Dr. Richard Simmonds, Veterinary Science</u>
Dr. Simmonds spent six years with NASA where he managed the Animal Testing components of the Apollo Lunar Quarantine Program and a joint space biology program with the Soviet Union. His experiments flew on missions from Apollo through Skylab. He also served at the Uniformed Services University of the Health Sciences in Bethesda, MD as Director of Instructional and Research Support and Associate Professor of Physiology and Surgery. He continues to teach at the University of Nevada Medical School and College of Agriculture, Biotechnology, and Natural Resources.

Additional Team Advisers:

Richard Brong teaches courses in physical and geosciences and is a certified pilot with an education from Embry-Riddle Aeronautical University.

Dr. Stephen McFarlane, medical researcher and Dean Emeritus of the Nevada School of Medicine, served as Interim President of UNR and authored the leading text on the voice & voice therapy.

Dr. Steve Metzger is a Planetary Research Geologist studying dust devils on Mars via field work in the Nevada desert. He is also a science consultant and involved in K-12 education.

Meghan Collins is an Environmental Education Lead at Desert Research Institute and was awarded a 2016 grant from the Nevada NASA Space Grant for her work with Nevada's Challenger Center.

Tom Taormina worked at Mission Control during the Gemini, Apollo, and Shuttle era, and has dedicated his energies to endowing the legacy of NASA's space program.

Chef Craig Rodrigue was a master navigator in the Coast Guard, worked on an internet startup, and was trained as a classical chef. He currently teaches at TMCC and coaches award winning Skills USA Teams.