Challenger Learning Center

Monroe #1 BOCES Technology Services

Standards and Skills

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Steve Orcutt
steve_orcutt@boces.monroe.edu
15 Linden Park, Rochester, NY 14625
585-249-7890

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The Rochester Challenger Learning Center was created to inspire a student's interest in science and math. When students fly their Mission to Mars, not only do they have fun, but they also exercise the development of their Math, Science, and Technology Process Skills by completing curriculum-based activities aligned with Common Core Standards, 21st Century Skills and Next Generation Science Standards.

The goals of Challenger are to engage and increase student enthusiasm for science, math, and technology; improve student problem solving skills and enhance their critical thinking skills; to teach students the importance of teamwork and communication; to foster a long-term interest in science, math, and technology; and to inspire students to pursue that interest in their career choice.

HOW A CHALLENGER LEARNING CENTER MISSION SIMULATION WORKS

Prior to group missions, educators and group leaders participate in a mission preparation video conference and receive curriculum to help students understand the mission objectives and the concepts to complete their mission and to work on communication skills, problem-solving, and team skills. The class is divided in two teams, with both having the opportunity to experience being part of a Mission Control Team and a Spacecraft team.

The mission is divided into two parts. During the first half of the mission, the team will construct and launch a small unmanned spacecraft called a probe. During the second half of the mission, the goal is to achieve Martian orbit and retrieve a group of astronauts who have been on Mars for two years.

The Challenger Mission experience provides a means to increase students' science proficiency in an authentic setting. Through teamwork and communication, students gain access to a realistic scenario incorporating science, math, and technology skills from the perspective of a work and career setting.

Challenger Learning Center missions are learning environments embedded with activities and lessons aligned with Common Core State Standards, New York State Science Core Curriculum, and Next Generation Science Standards (NGSS).

STANDARDS AND SKILLS

COMMON CORE[1]: ELA-Literacy

Speaking and Listening – Comprehension and Collaboration CCSS.ELA-Literacy.SL6.1.

- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 6 topics, tests, and issues, building on others ideas and expressing their own clearly.

Reading: Informational Text – Key Ideas and Details CCSS.ELA-Literacy.RI.6.1.

- Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text

Reading: Informational Text – Craft and Structure CCSS.ELA-Literacy.RI.6.4.

- Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

Science and Technical Subjects – Integration of Knowledge and Ideas CCSS.ELA-Literacy. RST.6-8.7.

- Use spreadsheets, databases, tables, charts, graphs, statistics, mathematics, and information and computer technology to collate, summarize, and display data and to explore relationships between variables. Students should have opportunities to learn standard techniques for displaying, analyzing, and interpreting data; such techniques include different types of graphs, the identification of outliers in the data set, and averaging to reduce the effects of measurement error. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Science and Technical Subjects – Integration of Knowledge and Ideas CCSS.ELA-Literacy.RST.6-8.7.

- Students should have opportunities to learn standard techniques for displaying, analyzing, and interpreting data; such techniques include different types of graphs, the identification of outliers in the data set, and averaging to reduce the effects of measurement error. Integrate quantitative or technical information express words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Reading Informational Text – Craft and Structure CCSS.ELA-Literacy.RI.6.4.

- Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

[1] https://www.engageny.org/common-core-curriculum (Accessed July, 2015)

Science and Technical Subjects – Key Ideas and Details CCSS.ELA-Literacy.RST.6-8.3

- Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

COMMON CORE: Math

The Number System CCSS.Math.Content.6.NS.C.5.

- Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts.

NEW YORK STATE SCIENCE CORE CURRICULUM

Intermediate Level Science (5-8)[2]

Science process skills should be based on a series of discoveries. Students learn more effectively when they have a central role in the discovery process. To that end, Standards 1, 2, 6, and 7 incorporate in the Intermediate Core Curriculum a student-centered, problem-solving approach to intermediate science.

STANDARD 1 – Analysis, Inquiry, and Design
Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

STANDARD 2 – Information Systems
Students will access, generate, process, and transfer information, using appropriate technologies.

STANDARD 6 – Interconnectedness: Common Themes
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

STANDARD 7 – Interdisciplinary Problem Solving
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Challenger® CENTER

[2] http://www.p12.nysed.gov/ciai/mst/pub/intersci.pdf (Accessed July, 2015)

NEXT GENERATION SCIENCE STANDARDS

The Next Generation Science Standards (NGSS) are composed of the three dimensions – Practices, Crosscutting Concepts, and Disciplinary Core Ideas – from the National Research Council's (NRC) Framework. The Framework describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge.

NEXT GENERATION SCIENCE STANDARDS
Framework Practices[3]

Practice 4: Analyzing and Interpreting Data

- Collecting and Analyzing and Communicating Scientific Data to inspire students to consider careers in STEM.

- Use spreadsheets, databases, tables, charts, graphs, statistics, mathematics, and information and computer technology to collate, summarize, and display data and to explore relationships between variables.

Practice 5: Using Mathematics and Computational Thinking

- Use grade-level-appropriate understanding of mathematics and statistics in analyzing data.

Practice 7: Engaging in Argument from Evidence

- Construct a scientific argument showing how data support a claim.

Practice 8: Obtaining, Evaluating, and Communicating Information

- Communicating in written or spoken form is another fundamental practice of science; it requires scientists to describe observations precisely, clarify their thinking, and justify their arguments.
- Evaluate individual and group communication for clarity, and work to improve communications.
- Practice in interpreting tables, diagrams, and charts and coordinating information conveyed by them with information in written text.
- Learn technical terms but also more general academic language, such as "analyze" or "correlation," which are not part of most students' everyday vocabulary and thus need specific elaboration if they are to make sense of scientific text.

[3] http://www.nextgenscience.org/sites/ngss/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf
(Accessed July, 2015)

21st CENTURY SKILLS[4]

The elements described are the knowledge, skills, and expertise students should master to succeed in work and life in the 21st century.

- Problem Solving and Critical Thinking
- Communication and Collaboration
- Flexibility and Adaptability
- Initiative and Self-Direction
- Productivity and Accountability
- Information, Communications and Technology (ITC) Literacy

[4] http://www.ocmboces.org/tfiles/folder1041/P21_Framework_Definitions.pdf (Accessed July, 2015)

STANDARDS IN PRACTICE: Student Outcomes

The effectiveness of the Challenger program is that the scenario encompasses a range of standards and skills for both ELA and Science while extending the students' experience for college and career readiness.

The concept of the Challenger Learning Center is embedded in the context of the existing curriculum and standards framework. It is a dynamic learning environment which may be used as a tool to capture student interest and provide a context for formative and summative evaluation for the school year.

The following section provides examples of learning activities correlated with standards based on the roles and tasks of the Challenger mission.

Challenger Team Assignments

Communication Team
The Communication team is responsible for using technology to send verbal messages and mission status between Mission Control and the Spacecraft. The team tracks parameters including mission elapsed time (M.E.T.) and mission progress.

Data Team
All printed data is handled by the Data Team. The team coordinates sending, receiving, and delivering messages between Mission Control and the Spacecraft. Additional duties including decoding encrypted messages for the mission.

Medical Team
The Medical Team tests crew members to determine their response time, skin temperature, and heart rate. Mission Control records and analyzes the data.

Isolation Team
In Mission Control, this team records data, performs calculations, and analyzes data concerning hazardous materials. The Spacecraft Team operates the robots and performs experiments simulating radioactivity, meteoroids, and hazardous chemicals.

Life Support Team
The Spacecraft Team monitors environmental conditions, solar panel efficiency, performs pH tests, and measures microscope field of view. The Mission Control Team records and graphs data in order to analyze information concerning the Life Support Systems for the Spacecraft.

Navigation Team
The Navigation Teams applies knowledge of both latitude and longitude to locate earth based tracking sites, sets the course for the Spacecraft, calculates distances in space, adjusts thrust and trajectory of the probe, identifies orbiting objects, and sets the landing parameters for the Spacecraft.

Media Team
This team is responsible for documenting the events of the mission. They use a digital camera to photograph the team at work in the decision-making process.

Probe Team
The Spacecraft Team constructs, tests, and repairs the probe. The Mission Control Team directs the construction of the probe and programs the probe computer.

The Remote Team
The Spacecraft Team runs tests on Martian rock and soil samples. The Mission Control Team records and analyzes their results, using latitude and longitude coordinates to plot the location of the rocks on a map of Mars.

STANDARDS IN PRACTICE

COMMON CORE

The three key shifts in English Language Arts (ELA) Common Core (Regular Practice with complex texts and their academic language; Reading, writing and speaking grounded in evidence from texts, both literal and informational; Building content through content-rich non-fiction) reflect the skills and knowledge students will need to succeed in college, career, and life. Listed below are examples of Common Core Standards alignment based on the Challenger Learning Center Mission Simulation.

Team	Skill Set Application	Standards Application Example
Communications	Speaking, Reading	*Reading Informational Text – Craft and Structure CCSS.ELA-Literacy.RI.6.4.* Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.
Data	Writing and Data Entry, Reading	*Reading Informational Text – Craft and Structure CCSS.ELA-Literacy.RI.6.4.* Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.
Medical	Reading, Graphing	*Science and Technical Subjects – Integration of Knowledge and Ideas CCSS.ELA-Literacy. RST.6-8.7.* Use spreadsheets, databases, tables, charts, graphs, statistics, mathematics, and information and computer technology to collate, summarize, and display data and to explore relationships between variables. Students should have opportunities to learn standard techniques for displaying, analyzing, and interpreting data; such techniques include different types of graphs, the identification of outliers in the data set, and averaging to reduce the effects of measurement error. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Isolation	Interpreting Data, Problem Solving, Reading	*Science and Technical Subjects – Integration of Knowledge and Ideas CCSS.ELA-Literacy.RST.6-8.7.* Students should have opportunities to learn standard techniques for displaying, analyzing, and interpreting data; such techniques include different types of graphs, the identification of outliers in the data set, and averaging to reduce the effects of measurement error. Integrate quantitative or technical information express words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
Life Support	Measurement, Estimation, Reading	*Science and Technical Subjects – Integration of Knowledge and Ideas CCSS.ELA-Literacy.RST.6-8.7.* Students should have opportunities to learn standard techniques for displaying, analyzing, and interpreting data; such techniques include different types of graphs, the identification of outliers in the data set, and averaging to reduce the effects of measurement error. Integrate quantitative or technical information express words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
Navigation	Number Sense, Reading, Problem Solving	*The Number System* *CCSS.Math.Content.6.NS.C.5.* Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts.
Media	Documentation, Technology Application, Communication	*CCSS.ELA-Literacy.RI.6.1.* Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 6 topics, tests, and issues, building on others ideas and expressing their own clearly.

Probe	Verbal Communication, Reading, Problem Solving	*Science and Technical Subjects – Key Ideas and Details CCSS.ELA-Literacy.RST.6-8.3* Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
Remote	Graphing, Data Interpretation, Describing Observations	*CCSS.Math.Content.6.NS.C.5.* Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts.

Next Generation Science Standards - Science and Engineering Practices

A Science Framework for K-12 Science Education expresses a vision in science education that requires students to operate at the nexus of three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas.

Key to the vision expressed in the *Framework* is for students to learn these disciplinary core ideas in the context of science and engineering practices. The importance of combining science and engineering practices and disciplinary core ideas is stated in the *Framework* as follows:

> *Standards and performance expectations that are aligned to the framework must take into account that students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content.* (NRC *Framework*, 2012, p. 218)

The eight practices of science and engineering that the *Framework* identifies as essential for all students to learn and describes in detail are listed below:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Listed below are examples of the practices of science and engineering the *Framework* identifies based on the Challenger Learning Center Mission Simulation.

MS-ESS1-3 Earth's Place in the Universe	
Students who demonstrate understanding can:	
MS-ESS1-3.	**Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [*Assessment Boundary: Assessment does not include recalling facts about properties of*

the planets and other solar system bodies.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings.	**ESS1.B: Earth and the Solar System** • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.	**Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. - ***Connections to Engineering,Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.

Connections to other DCIs in this grade-band:
MS.ESS2.A

Articulation of DCIs across grade-bands:
5.ESS1.B ; **HS.ESS1.B** ; **HS.ESS2.A**

Common Core State Standards Connections:

ELA/Literacy -

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-3)
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3)

Mathematics -

MP.2	Reason abstractly and quantitatively. (MS-ESS1-3)
6.RP.A.1	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-3)
7.RP.A.2	Recognize and represent proportional relationships between quantities. (MS-ESS1-3)

DOCUMENT BASED QUESTIONS

Directions:
Use this Flight Data Chart and the Flight Patch to answer the questions on the separate page.

Flight Data

CHALLENGER'S ASTRONAUTS (IN ORDER OF EXPERIENCE)

Astronaut	Total Flights	Mission Sequence	Separate Mission Totals Day: Hr: Min: Sec	Separate Mission Totals Orbits	Accumulated Mission Totals Day: Hr: Min: Sec	Accumulated Mission Totals Orbits
Ride	2	Sh07/Ch02	06: 02: 23: 59	98		
		Sh13/Ch06	08: 05: 23: 33	133	14: 07: 47: 32	231
McBride	1	Sh13/Ch06	08: 05: 23: 33	133	08: 05: 23: 33	133
McNair	2	Sh10/Ch04	07: 23: 15: 55	127		
		Sh25/Ch10	00: 00: 01: 13	0	07: 23: 17: 08	127
Fullerton	1	Sh19/Ch08	07: 22: 45: 26	126	07: 22: 45: 26	126
Scobee	2	Sh11/Ch05	06: 23: 40: 07	107		
		Sh25/Ch10	00: 00: 01: 13	0	06: 23: 41: 20	107
Gardner	1	Sh08/Ch03	06: 01: 08: 43	97	06: 01: 08: 43	97
Smith	1	Sh25/Ch10	00: 00: 01: 13	0	00: 00: 01: 13	0
Resnik	1	Sh25/Ch10	00: 00: 01: 13	0	00: 00: 01: 13	0
Onizuka	1	Sh25/Ch10	00: 00: 01: 13	0	00: 00: 01: 13	0
Mcauliffe	1	Sh25/Ch10	00: 00: 01: 13	0	00: 00: 01: 13	0
Jarvis	1	Sh25/Ch10	00: 00: 01: 13	0	00: 00: 01: 13	0

Challenger Flight Patch
51-L

DOCUMENT BASED QUESTIONS

NAME_____

DIRECTIONS: Use the separate Flight Data Chart and Flight Patch to help answer these questions.

1. How many astronauts flew on the 51-L shuttle mission? _____

2. Which astronaut had the most experience in time and orbits?

_____

3. How many astronauts flew **more** than a single shuttle mission? _____

4. Which two astronauts, from the Challenger 51-L crew, had previous experience in a space shuttle? **Hint: look in the 'total flights' column.**

_____ and _____

5. What was Astronaut Fullerton's accumulated flight time?

days:_____ hours:_____ Minutes:_____ seconds:_____

6. What is the combined accumulated mission total, for the two Challenger 51-L crew members, with the most experience? **(answer from #4 will help)**

days:_____ hours:_____ minutes:_____ seconds:_____

BONUS: Look at the accumulated Mission Totals for the last five astronauts on the chart. How long was each of their flights? min: _____ sec:_____
Why do you think their mission was so brief?

_____

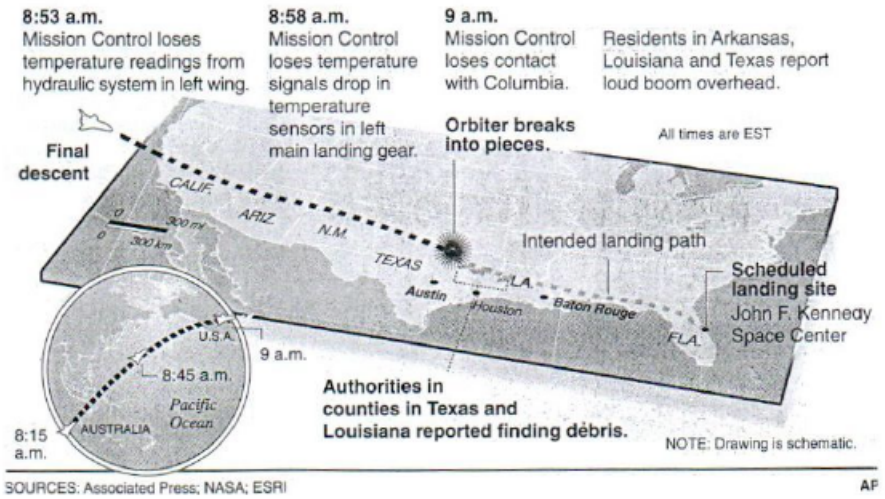
_____

DESCENT OF COLUMBIA

Name_____

USE THE MAP AND TEXT TO ANSWER THE QUESTIONS

Space shuttle Columbia broke apart over Texas one hour into its descent Saturday, approximately 40 miles above ground and traveling at 12,500 mph. The orbiter was scheduled to land in Florida at John F. Kennedy Space Center at 9:16 a.m. EST.



1. Which 2 states have reported finding debris from the space shuttle Columbia?

2. Where was the Columbia scheduled to land? _____

3. How fast was the shuttle traveling? _____

4. Name the six states the Columbia was supposed to fly over during its final decent.

5. Over which state did the Orbiter break into pieces? _____

6. At what time did Mission Control lose contact with Columbia? _____

7. Was the Columbia returning home in the morning, afternoon, or evening? How do you know?_____

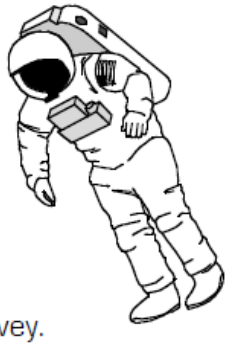
8. What continent is shown on the inset map? _____

9. What body of water was the Columbia over at 8:45 a.m.? _____

10. Why is the dotted line dark before Texas, and lighter after?
    a. To show where it was sunlight and where it was dark.
    b. the artist's pen was running out of ink
    c. to represent where the shuttle actually flew, and where it should have flown

Dear Teacher,

We'd like to know how we did with your mission! Our aim is to continue to improve our facility and services to better meet your needs. We would like feedback from both you and your students about today's mission.



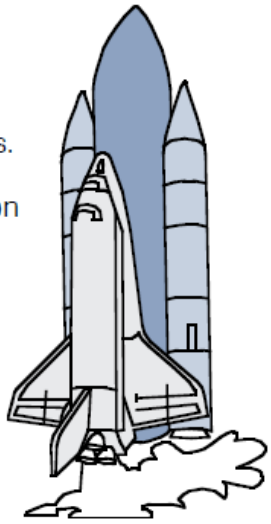
For Your Students:
Please make a copy of the attached survey for each participating student. It should only take a moment to fill out. Please collect their completed surveys and use the attached envelope to send them through the inter-school mail system.

For Yourself:
Please log on to the internet to complete our Web-based Teacher Survey.

Go to the address:

www.monroe.edu/technologyservices/challenger/surveys/challenger_form.php

and follow all instructions there to submit your feedback.



The information you and your students provide is very valuable to us. We take all suggestions and comments seriously, in an effort to continue making the Challenger Learning Center the most education (and fun) experience possible.

Thank you for your time and effort!

Sincerely,

The Challenger Learning Center

POST-MISSION ACTIVITIES
STUDENT EVALUATION

School:_____

What was your job?

What was the best part of your job?

How would you rate your trip to the Challenger Learning Center on a scale of 1-10?

Not Educational Very Educational

1 2 3 4 5 6 7 8 9 10

Not Exciting Very Exciting

1 2 3 4 5 6 7 8 9 10

How would you rate your interest in Science after your trip to Challenger?

More interested Same Less Interested

Would you recommend the trip to a friend? Why?

Would you come to the Challenger Center again? Why?

Do you think your teacher should bring next year's class? Why?

Would you be interested in a Challenger Summer Camp that includes engineering activities as well as missions? Why?

What was your favorite part of the mission?

What was your least favorite part of the mission?

If you could change one thing about the mission, what would it be?

Comments

SCHEDULING AND CONTACT INFORMATION

The Challenger Center gives students an opportunity to use Math, Science, and Technology in an authentic learning environment. Our state-of-the-art facility makes science and math fun and inspirational for youngsters by giving them a chance to explore careers related to Math, Science, and Technology. Students work cooperatively to solve problems and tasks which are based on the New York State Assessments in Science. By tying into current events and using the newest educational technology, Challenger strives to have a positive impact on student learning.

Teachers who have never flown a mission should attend our Teacher Orientation night. At the orientation, we will give you a Teacher's Manual, walk through some suggested training activities, and demonstrate how the simulation will work for your students. If you have not attended an orientation in recent years, consider coming in for a refresher. It's an opportunity for you to go through each station and see some of the changes and updates that we've recently made.

We will be happy to book as many flights as you like. If there are no openings that meet your needs, ask us about opportunities for after school missions. Give us a call at (585) 473-7490.

We currently offer a Challenger/RMSC combo package.

To Schedule:

If you are from a school district in New York State, contact Debra Croce at debra_croce@boces.monroe.edu or 585-249-7063 for pricing and scheduling information.

All others, information is available through the Center for Interactive Learning and Collaboration website at http://www.cilc.org/ under "Content Provider Programs".

Contact Steve Orcutt at steve_orcutt@boces.monroe.edu or (585) 249-7890 for more information about programs and curriculum.

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