FUTURE Problem Solving

ACTIVITY UNIT

Topic

Space Exploration

Science & Technology

14

Activities

Supports all these programs

INCLUDED INSIDE:

- 12 lesson plans
- 3 practice future scenes
- A variety of tools, research, and metacognition activities
- A variety of specific problem-solving step activities

GRADES 4-12

Practice Problem 2 | 2025-2026

This publication is a compilation of the hard work of many people. Special thanks are extended to our curriculum authors Kathy Frazier and Kori Frazier Morgan.

FUTURE Problem Solving
ACTIVITY UNIT

Topic Activity Contents

How might space exploration change the way humanity exists on Earth and throughout our Universe in the future?

Activity Focus Areas Icons

Our activity unit on each topic contains a wealth of curricular resources for use with students in a variety of settings, including out-of-school time. The highly engaging activities incorporate best practices and come with step-by-step lesson plans for research-based independent and collaborative work. Each activity is designed to help students gain insight into a specific real world topic and learn the Future Problem Solving 6-step process. For ease of use, we display icons on each lesson plan to indicate the activity focus.

Research
Explore the topic using multimedia research for background and understanding.

Tools
Utilize tools for problem solving, either generating new ideas or focusing existing ideas, in the activity.

Metacognition
Metacognition prompts allow students to explore their thought processes related to the problem-solving process, their teamwork, and their performance.

Future Scene
Practice future scenes allow students to apply the problem-solving process.

Action Plan Presentation
Tips and instructions help students present their Step 6 action plans.

Steps 1 - 6
TIn each activity, students explore specific steps of the Future Problem Solving process for deeper understanding and application of creative and critical thinking skills.

Identify Challenges
Generate challenges or issues related to a specific situation.

Select an Underlying Problem
Analyze possible challenges to determine a single focused area to address.

Produce Solution Ideas
Generate a variety of potential solution ideas to resolve the selected underlying problem.

Select Criteria
Create criteria to measure the merit of solution ideas.

Apply Criteria to Top Solutions
Evaluate solution ideas using student-designed criteria to identify the most promising solution.

Develop an Action Plan
Based on the strongest solution develop a plan of action to explain and implement the best solution.

For more information about Future Problem Solving, our proven 6-step process, and how it connects to a wide variety of education standards, visit resources.futureproblemsolving.org.

FUTURE Problem Solving
ACTIVITY UNIT

Education Standards Alignment

We also highlight how each activity lesson plan aligns with English Language Arts and Literacy education standard strands. Our Future Problem Solving process fulfills a wide variety of education standards. We take connecting with these standards into account when developing all our program materials so teachers can easily tailor activities to meet their specific education system and local requirements. Use the legend on the following page to connect lesson plans to specific reading, writing, speaking, and listening standards.

	Education Standard Strands Addressed											
Space Exploration Activity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PAGE #**
Launching Practice Problem 2	●	●	●	●	●	●	●	●			●	**7**
Blast Off!	●	●	●	●	●	●			●	●	●	**10**
Research Countdown	●	●	●	●	●	●	●	●	●	●	●	**13**
A Research Showcase	●	●			●	●	●	●	●	●	●	**19**
Debating the Final Frontier	●	●	●	●	●	●	●	●	●	●	●	**22**
Space Challenge - Mission Control	●	●	●	●	●				●		●	**31**
Challenge Chaos	●	●	●	●	●	●	●	●	●	●	●	**36**
Underlying Problem Exploration	●	●	●	●	●	●	●	●	●	●	●	**45**
Red Alert	●	●	●	●	●	●	●	●	●	●	●	**56**
To Infinity and Beyond	●	●	●	●	●	●	●	●	●	●	●	**59**
Cosmic Criteria Flybys	●	●	●	●		●	●	●	●	●	●	**66**
The Right Stuff, Practice Makes Perfect	●	●	●	●	●	●	●	●	●	●	●	**74**
Practice Future Scene			●	●	●	●					●	**83**
Back to the Future	●	●					●	●				**85**

1. Comprehension and Collaboration
2. Presentation of Knowledge and Ideas
3. Reading Key Ideas and Details
4. Literacy Craft and Structure
5. Integration of Knowledge and Ideas
6. Range of Reading and Level of Text Complexity
7. Writing Text Types and Purposes
8. Production and Distribution of Writing
9. Research to Build and Present Knowledge
10. Range of Writing
11. Vocabulary Acquisition and Use

For more information about Future Problem Solving, our proven 6-step process, and how it connects to a wide variety of education standards, visit resources.futureproblemsolving.org.

Topic Activity Unit Lesson Plans Standard Strands Addressed

SPEAKING & LISTENING		**COMPREHENSION AND COLLABORATION**
	1	Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
	2	Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
	3	Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.
		PRESENTATION OF KNOWLEDGE AND IDEAS
	4	Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
	5	Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.
	6	Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.
READING & LITERACY		**KEY IDEAS AND DETAILS**
	1	Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
	2	Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
	3	Analyze how and why individuals, events, and ideas develop and interact over the course of a text.
		CRAFT AND STRUCTURE
	4	Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
	5	Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.
	6	Assess how point of view or purpose shapes the content and style of a text.
		INTEGRATION OF KNOWLEDGE AND IDEAS
	7	Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.
	8	Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
	9	Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.
		RANGE OF READING AND LEVEL OF TEXT COMPLEXITY
	10	Read and comprehend complex literary and informational texts independently and proficiently.
WRITING		**TEXT TYPES AND PURPOSES**
	1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
	2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
	3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
		PRODUCTION AND DISTRIBUTION OF WRITING
	4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
	5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
	6	Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
		RESEARCH TO BUILD AND PRESENT KNOWLEDGE
	7	Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
	8	Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
	9	Draw evidence from literary and/or informational texts to support analysis, reflection, and research.
		RANGE OF WRITING
	10	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.
LANGUAGE & VOCABULARY		**VOCABULARY ACQUISITION AND USE**
	1	Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.
	2	Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
	3	Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college- and career-readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

FUTURE Problem Solving LESSON PLAN

Navigating Evaluator Feedback for Success

M

Objectives

- Students will analyze their evaluator feedback from the Invasive Species practice problem to identify their successes and areas for improvement.
- Teams will develop specific goals to enhance their performance on the Space Exploration practice problem.
- Teams will create a plan for their Space Exploration work to implement evaluator feedback.

Standards Addressed
Speaking & Listening
1, 2, 3, 5, 6
Reading & Literacy
1, 2, 4, 5, 7, 8, 10
Writing
2, 4, 5
Language & Vocabulary
2, 3

Materials

- **Invasive Species Evaluation Scoresheets**, see Preparation
- **Goal Setting Chart template,** 1 for display (page 9)
- Notebook paper and writing utensils (Students could provide their own.)
- Large paper
- Markers

Preparation

1. Review the **Invasive Species Evaluation Scoresheets** you received after submitting booklets for Invasive Species. It would be helpful to prepare some notes for yourself about key scores and points made by the evaluators for each team/individual. Focus on strengths and areas for improvement.
2. Determine how you will make the Invasive Species scoresheets available to teams: 1 per team or 1 per student. Prepare the scoresheets for distribution.
3. Determine how you will share the **Goal Setting Chart** template.
4. Review the deadline for submitting the Space Exploration booklet and develop a timeline for student work.

Procedure

1	**Say:** *It is exciting to embark on our second Future Problem Solving practice problem, Space Exploration. Before launching this new adventure, let's set our course by reviewing the evaluation feedback from Invasive Species. This will help us navigate improvements and build on our strengths as we prepare for our next mission, Space Exploration. At the end of this lesson, you and your team will be developing a Goal Setting Chart for Space Exploration.*
2	**Say:** *Get out a piece of paper and something to write with so you can make notes as we go along.*
3	Distribute the **Invasive Species Evaluation Scoresheets.** Provide a few minutes for students to look over the score sheets together before identifying strengths and weaknesses.
4	**Say:** *Let's first identify our areas of strength. What steps of the Future Problem Solving process did you excel in? As you share your ideas aloud, also make some notes on your paper about your areas of strength.* • Identify challenges • Select an underlying problem • Produce solution ideas

Coaching Tip

Use additional Resource Library tools like the Future Problem Solving 6-step Infographic poster to provide a roadmap for your students as they learn a problem-solving model for any situation.

Navigating Evaluator Feedback for Success

M

Procedure, continued

5	**Say:** *Now, let's examine the steps of the process and identify areas where our scores need improvement. Again, make some notes on your own paper.* • Identify challenges • Select an underlying problem • Produce solution ideas
6	Discuss how students might improve their work in these areas. This might include: • Strengthening research connected to identifying challenges • Giving more information in challenges for clarity • Strengthening the underlying problem. Are all the components included? Do you need to look for a more important underlying problem connected to the future scene charge? • Increasing originality and fluency in solutions. • Elaborating solutions with all four of the who, what, how, and why.
7	**Say:** *Now that we have identified our strengths and areas for improvement, it's time to collaborate with your team and develop specific goals to enhance your performance for Space Exploration.*
8	Share the **Goal Setting Chart** template. Distribute large paper and markers.
9	Provide time for teams to collaborate, develop their goals, and create their **Goal Setting Chart.**
10	**Say:** *Let's create a timeline to keep us on course.*
11	Present the Space Exploration deadline and develop a timeline on the **Goal Setting Chart.**

Standards Addressed
Speaking & Listening
1, 2, 3, 5, 6
Reading & Literacy
1, 2, 4, 5, 7, 8, 10
Writing
2, 4, 5
Language & Vocabulary
2, 3

Closure

1. Lead students to reflect on the importance of setting achievable goals that address the evaluator's feedback. How will this lesson lead to success in analyzing the Space Exploration future scene and completing the booklet?
2. Post the completed **Goal Setting Charts** and remind students to review them before each team meeting to determine whether they are on course.

TEMPLATE

Goal Setting Chart

GOAL SETTING CHART

STRENGTHS

AREAS OF IMPROVEMENT

SPECIFIC GOALS

TIMELINE

FUTURE Problem Solving LESSON PLAN

Structured Overview

R

Objectives

- Students will analyze research about Space Exploration.
- Students will organize their research by creating a Structured Overview related to identified themes, including Innovations, Ethical issues, What are we looking for?, and Pushing the limits.

Standards Addressed
Speaking & Listening
1, 2, 4, 5
Reading & Literacy
1, 2, 4, 7, 10
Writing
7, 8, 9, 10
Language & Vocabulary
1, 2, 3

Materials

- **Research Bank**, 1 per student, preferably shared electronically (page 12)
- Computer access for reading online articles
- Bulletin board paper, construction paper, etc.
- Sticky notes or note cards
- Glue or tape
- Highlighters
- Access to research on the topic of Space Exploration, such as the **Research Bank** or any other available resources

Preparation

1. Construct a wall-sized version of the diagram below and hang it on the wall. (Students can help with this.)
2. Leave enough room for students to post information under each subtopic and create new subtopics as necessary.
3. Plan to leave this **Structured Overview** hanging in the classroom so that students can add to it throughout the unit.
4. You may want to plan to divide the articles in the **Research Bank** among all the students so that every student is not required to read every article.

Structured Overview		
Innovations	**Ethical issues**	**What are we looking for?**
Pushing the limits		

FUTURE Problem Solving
LESSON PLAN

Structured Overview

R

Procedure

1	Call students' attention to the diagram on the wall.
2	**Say:** *A **Structured Overview** provides a visual picture of information on a topic. It can help you make sense of a topic by breaking it into smaller pieces so you can see and understand relationships among the pieces. Listed below the topic of Space Exploration are several subtopics. As you do research, you may want to take notes on your own paper. When you find important facts, challenges, and solution ideas, write them on a note card or sticky note and attach it under the relevant subtopic on the chart – one idea per card. If an idea does not fit a subtopic listed, create a new subtopic for the chart. Highlight any important topic vocabulary words. Be sure to read what has already been posted so that we do not have repeated information. We will be able to watch our Structured Overview grow as new information is added. You can refer to the Structured Overview and your own notes as we learn about Space Exploration.*
3	Distribute the **Research Bank.**
4	Review the directions. Note: At this point you may want to assign the articles to different students.
5	Provide work time.
6	When the students have had time to post ideas, call time.
7	Call attention to the ideas posted on the **Structured Overview.** Read through them with students.
8	**Ask:** *Are there any duplicate ideas that can be removed?" Remove duplicates so that only one version of that idea remains.*
9	Lead a discussion on what students learned about Space Exploration.

Standards Addressed
Speaking & Listening
1, 2, 4, 5
Reading & Literacy
1, 2, 4, 7, 10
Writing
7, 8, 9, 10
Language & Vocabulary
1, 2, 3

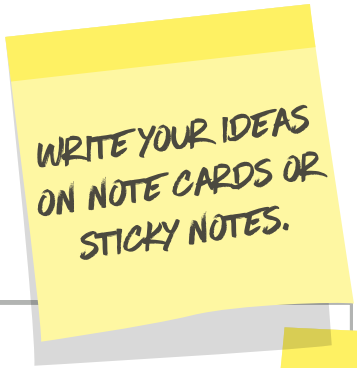
Closure

Encourage students to continue to post other ideas on the **Structured Overview** during their research. Remind them to read what others have posted so that the design is not crowded with duplicate ideas.

Name _____

Research Bank

Directions: Examine the articles in the research bank and any others available (such as in the research unit chapter on Space Exploration) to find facts, causes, effects, consequences, and solutions related to Space Exploration. Write your ideas on note cards or sticky notes – one for each idea – and post them under the appropriate subtopic on the class **Structured Overview**. Be sure to read the other posted ideas to avoid duplicates. If an idea does not fit under a subtopic, create a new subtopic.



Space Exploration Research Bank

10 Inventions We Have Because of Space Travel | **It's Rocket Science**

Analysis: Why trash in space is a major problem with no clear fix | **PBS**

The Astronaut's Dilemma: What Happens to Human Bodies in Space | **Museum of Science**

Can Space Tourism Ever Be Ethical? | **PBS (9:42)**

Eight ethical questions about exploring outer space that need answers | **The Conversation**

The Ethics of Space Exploration | **The Blue Marble Space Institute of Science**

The Ethics of Space Exploration | **Trilateral Research**
Note: this may be suited for more advanced readers.

The Future | **NASA**

How Technology From the Space Race Changed the World | **Northrop Grumman**

The Human Body in Space | **NASA**

Mining in Space is Coming | **The Milken Institute Review**

Space Exploration | **Britannica Kids**

Space Exploration | **Britannica Kids**
Note: See the sidebar for article subtopics.

Where will space exploration take us in the next 50 years? | **BBC Ideas (4:59)**

Why Go To Space? | **NASA**
Follow the arrows to read a variety of points about this sub-topic and others.

FUTURE Problem Solving LESSON PLAN

Reviewing Important Concepts

R

Objectives

- Students will demonstrate their understanding of key space exploration concepts and vocabulary.
- Students will develop teamwork and collaboration skills as they analyze their space exploration research.

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 2, 3, 4, 7, 10
Writing
1, 2, 4, 5, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

Materials

- **Challenge Card Questions**, 1 for coach reference. See Preparation. (page 15)
- **Challenge Card Questions and Answers**, 1 for coach reference. See Preparation. (pages 16-17)
- **Blast-Off Board**, 1 per team (page 18)
- Resource Tokens (Poker chips, pennies, bingo chips, squares of construction paper, etc.; 20 per team)
- Blank note cards or sticky notes (20 per team)
- Blank paper for taking notes and brainstorming answers (Students could provide their own.)

Preparation

1. Determine if you will read the questions aloud from the Challenge Cards, write them on note cards and pass them around to students, or show them in a slide presentation, with questions and answers included on slides. Prepare accordingly.
2. Gather the tokens.
3. Determine how to divide the students into four teams of 3, 4, or 5 students each.

Procedure

1	**Say:** *You've all been diligently researching our new topic of Space Exploration, and today is a big day! It's time to put your knowledge to the test and prepare to launch a space mission. We're going to play a game called Research Countdown that will let you practice the main themes and vocabulary in this topic.*
2	Divide the class into teams. Distribute a **Blast-Off Board**, ten tokens, and blank note cards or sticky notes to each team.
3	**Say:** *In this game, you are teams of astronauts preparing to launch a space mission. You start with ten tokens representing the resources you need to launch. Put those ten tokens in the resource tank. The catch? You need 20 tokens to go into space! You must earn the additional tokens by answering questions related to Space Exploration. You may use paper and pencil to keep up with the answers you discuss with your team.*
4	**Say:** *I will read each challenge question. You will then have two minutes to discuss the question with your team and come up with an answer. Write your answer on one of your cards and, when you are ready, hand the card to me. I will read the answers aloud. Each team that answers correctly will receive another token to put in the resource tank for your spaceship on the **Blast-Off Board**. However, if you answer incorrectly, your team loses a token. The first team with 20 resource tokens in their spaceship's resource tank successfully launches their mission and wins the game.*
5	Play the game.

FUTURE Problem Solving
LESSON PLAN

Reviewing Important Concepts in Space Exploration

R

Closure

1. Ask the students what strategies their teams used to work through the more difficult challenge cards and how their team worked together.
2. Ask each team to develop and share a new challenge card question with the group.
3. **Say**: *You've done a great job so far with learning about Space Exploration. Next, we will put these concepts to work by applying them to the Future Problem Solving process.*

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 2, 3, 4, 7, 10
Writing
1, 2, 4, 5, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

Name _____

Challenge Card Questions

1. What is microgravity?
2. What is space junk and why is it such a concern for space exploration?
3. What is the Overview Effect, and how does it influence astronauts?
4. What are the ethical concerns associate with colonizing other planets?
5. What is the Outer Space Treaty, and why is it important?
6. What innovations from space exploration have improved life on Earth?
7. What is cosmic radiation, and why is it dangerous?
8. Why is muscle atrophy a common issue for astronauts in space?
9. What are the key goals of space exploration?
10. Why do astronauts experience bone density loss in space?
11. What are exoplanets, and why are they important in space exploration?
12. What is the International Space Station (ISS), and why is it significant?
13. Name 3 challenges astronauts face on long-term space missions.
14. What are the benefits of international cooperation in space exploration?
15. What is the “Planet B” concept, and why is it controversial?
16. Why is it difficult to travel to other solar systems, and what is one proposed solution?
17. What is the role of satellites in space exploration, and how do they benefit life on Earth?
18. What is the role of water in space exploration, and why is it considered a valuable resource on other planets?
19. What is space tourism, and what are some potential challenges it faces?
20. What is terraforming, and why is it considered for planets like Mars?
21. What are space elevators, and how could they revolutionize space travel?
22. What is the role of artificial intelligence (AI) in space exploration?
23. What is astrobiology and why is it important to space exploration?
24. What is planetary protection, and why is it important?

FUTURE Problem Solving
ANSWER KEY

Challenge Card

R

1. **What is microgravity?**
   - Microgravity is a condition where objects appear to be weightless due to the very weak gravitational force, commonly experienced in space.
2. **What is space junk and why is it such a concern for space exploration?**
   - Any piece of machinery or debris left by humans in space. Because the debris travels at high rates of speed, any collision of debris with space craft or satellites can cause significant damage to machinery or humans.
3. **What is the Overview Effect, and how does it influence astronauts?**
   - The Overview Effect is a cognitive shift that occurs when astronauts view Earth from space, making them aware of the planet's fragility and interconnectedness.
4. **What are the ethical concerns associate with colonizing other planets?**
   - Ethical concerns include potential harm to alien ecosystems, exploitation of resources, and the environmental impact of human presence on other planets.
5. **What is the Outer Space Treaty, and why is it important?**
   - The Outer Space Treaty prevents nations from claiming ownership of celestial bodies, ensuring peaceful exploration, and preventing territorial disputes in space.
6. **What innovations from space exploration have improved life on Earth?**
   - Innovations include medical imaging (e.g., MRIs), satellite communication, water purification systems, and materials like memory foam.
7. **What is cosmic radiation, and why is it dangerous?**
   - Cosmic radiation is high-energy radiation from space that can penetrate spacecraft and harm astronauts by damaging tissue and increasing cancer risk.
8. **Why is muscle atrophy a common issue for astronauts in space?**
   - In microgravity, astronauts' muscles weaken due to the lack of resistance, causing muscle atrophy over time.
9. **What are the key goals of space exploration?**
   - Key goals include searching for life on other planets, understanding the formation of stars and galaxies, and discovering new resources in space.
10. **Why do astronauts experience bone density loss in space?**
    - In microgravity, bones lose density due to the lack of mechanical stress that normally strengthens them on Earth.
11. **What are exoplanets, and why are they important in space exploration?**
    - Exoplanets are planets outside our solar system. They are important because some may have conditions suitable for life, making them prime targets for exploration.
12. **What is the International Space Station (ISS), and why is it significant?**
    - The ISS is a habitable satellite orbiting Earth, used for international scientific research and cooperation, advancing our knowledge of space and its effects on the human body.
13. **Name 3 challenges astronauts face on long-term space missions.**
    - Challenges include exposure to radiation, muscle and bone loss, psychological stress, and the logistical difficulty of maintaining supplies and equipment.
14. **What are the benefits of international cooperation in space exploration?**
    - International cooperation allows countries to share resources, technology, and expertise, leading to more successful missions and discoveries, like with the ISS.

FUTURE Problem Solving ANSWER KEY

Challenge Card

R

15. **What is the "Planet B" concept, and why is it controversial?**
    - The "Planet B" concept involves finding another habitable planet for humans in case Earth becomes uninhabitable. It's controversial because some argue that we should focus on preserving Earth.
16. **Why is it difficult to travel to other solar systems, and what is one proposed solution?**
    - The vast distances between solar systems make travel difficult, as even the closes system (Alpha Centauri) would take over 148,000 years with current technology. One proposed solution is developing faster spacecraft, possibly using advanced propulsion like ion drives or light sails.
17. **What is the role of satellites in space exploration, and how do they benefit life on Earth?**
    - Satellites are crucial for communication, weather monitoring, GPS, and scientific research. They benefit life on Earth by improving communication forecasting weather events, and providing data for environmental monitoring.
18. **What is the role of water in space exploration, and why is it considered a valuable resource on other planets?**
    - Water is crucial for life. In space exploration, it's needed for drinking, growing food, and generating oxygen. Finding water on other planets or moons is key to determining their habitability and supporting future human exploration or colonization.
19. **What is space tourism, and what are some potential challenges it faces?**
    - Space tourism refers to commercial travel for non-professional astronauts into space. Challenges include high costs, safety risks, environmental concerns due to rocket launches, and the belief that we need to focus on protecting our planet rather than recreational space
20. travel.

    What is terraforming, and why is it considered for planets like Mars?
    - Terraforming is the process of altering a planet's environment to make it habitable for humans. It is considered for Mars because it might offer a future location for human settlement if we can
21. change its atmosphere, temperature, and ecology.

    What are space elevators, and how could they revolutionize space travel?
    - A space elevator is a proposed system consisting of a cable anchored to Earth and extending into space. It could revolutionize space travel by making it cheaper and more efficient to
22. transport materials and people to orbit without the need for rockets.

    What is the role of artificial intelligence (AI) in space exploration?
    - AI plays a key role in space exploration by automating spacecraft operations, analyzing large data sets from space missions, piloting autonomous rovers, and helping astronauts make
23. decisions in complex environments.

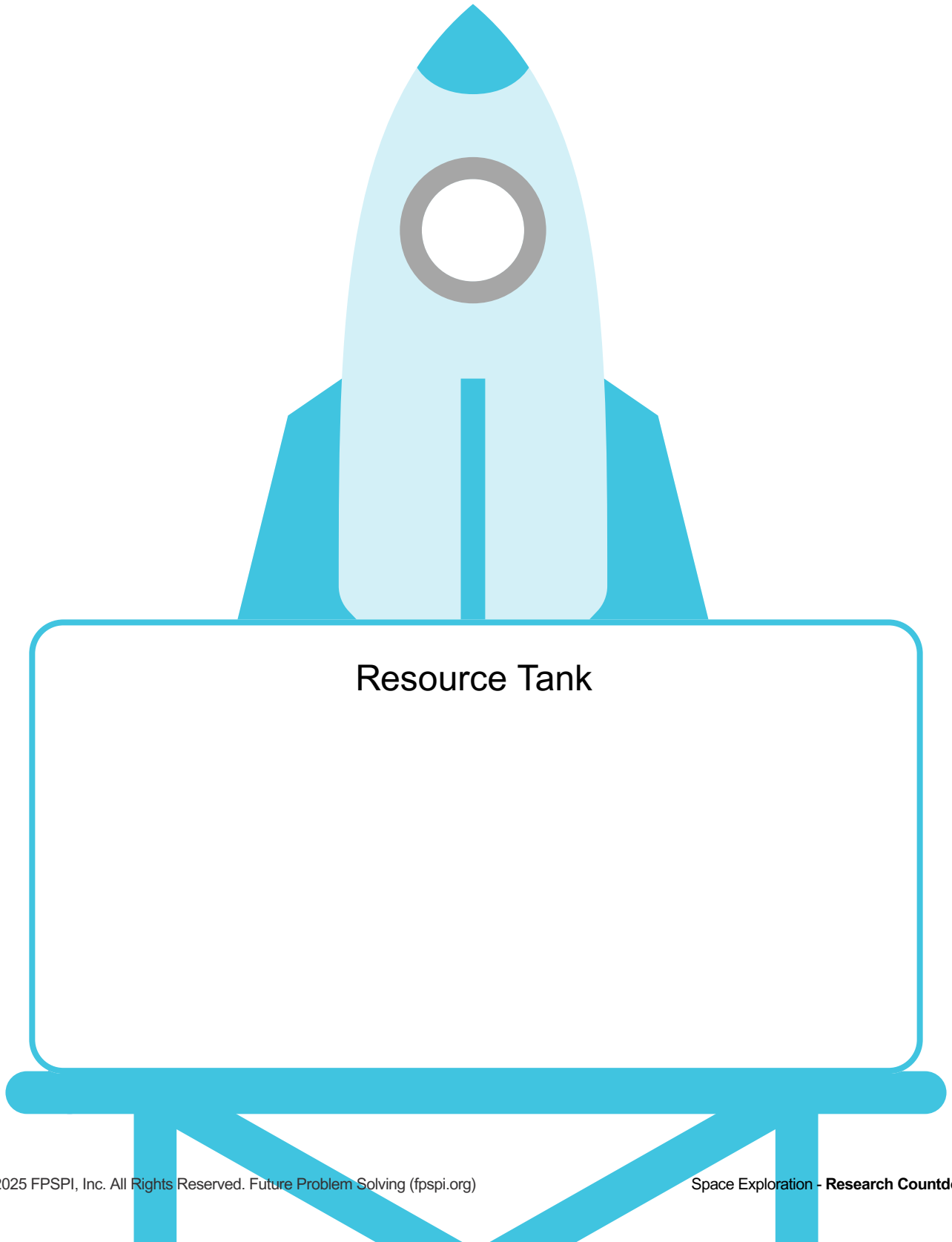
    What is astrobiology and why is it important to space exploration?
    - Astrobiology is the study of life in the universe, including the search for life on other planets. It helps us understand the conditions required for life, where we might find life beyond Earth, and
24. how life could survive in extreme environments.

    What is planetary protection, and why is it important?
    - Planetary protection refers to the practice of preventing biological contamination of other planets and moons by Earth microbes, and vice versa. It is important to avoid interfering with extraterrestrial ecosystems and to ensure that scientific investigations are not compromised.

Name _____

Blast Off Board

Directions: For each correct answer add a token to the resource tank for your spaceship on the Blast-Off Board. For each incorrect answer remove a token. The first team with 20 resource tokens in their spaceship's resource tank successfully launches their mission and wins the game.



FUTURE Problem Solving
LESSON PLAN

Creative Projects: Share What You Have Learned

R

Objectives

- Students will demonstrate their understanding of key concepts in Space Exploration.
- Students will synthesize their Space Exploration research, choosing a creative format, such as visual, musical, written, or using technology.

Standards Addressed
Speaking & Listening
1, 2, 4, 5, 6
Reading & Literacy
7, 8, 10
Writing
2, 4, 5, 6, 8, 9, 10
Language & Vocabulary
1, 2, 3

Materials

- **Creative Projects: Share What You Have Learned** Choice Board, 1 per student (page 20)
- Materials for the selected projects (provided by students)
- **Choice Board Rubric**, 1 per student plus extras for your use in assessing the projects (page 21)

Preparation

1. Determine if you will allow students to work alone or in small groups.
2. Determine a timeline and due date for the projects.

Procedure

1	**Say:** *Now that you have completed learned a lot about Space Exploration, the Research Showcase will allow you to share your understanding of Space Exploration through various creative and research-based projects.*
2	Distribute **Creative Projects: Share What You Have Learned.**
3	Review the selections on the **Choice Board.**
4	**Say:** *Notice that the center box allows you to develop your own idea. Discuss your plan with me for approval if you have an idea not listed on the* ***Choice Board.***
5	Tell students if you are allowing small group work or if they will be working alone.
6	Distribute and review the **Choice Board Rubric.**
7	Provide a timeline and due date.
8	Students will select a project aligned with their interests and begin work.

Closure

1. Students will develop a Research Showcase Gallery to display their finished projects.
2. Select a date and place for the Showcase.
3. Create invitations and make announcements at school.
4. After the Showcase, direct students to give their own projects a score using the **Choice Board Rubric** and hand them in to you as a formative assessment.

Name _____

Creative Projects: Share What You Have Learned

R

Directions

1. Choose a project from the Space Exploration Choice Board to share an important area of your Space Exploration research.
2. Develop your ideas for your project.
3. Gather needed materials.

SPACE EXPLORATION CHOICE BOARD

Choose one of the options below to creatively share your research.

Tiki-Toki.com

Visit this website to create a virtual Space Exploration Timeline highlighting key moments in space exploration history. Include dates, images, and descriptions.

Create a Space Exploration Infographic

Visit one of the following websites and select atemplate. Review your research and create an Infographic.
https://piktochart.com/ or https://www.canva.com/

iMovie

What will Space Exploration be like in the future? Create a scenario based on the trends identified in your research. Write a movie script and film it. Lights, Camera, Action!

Compose a Space Exploration Rap

Have some fun with the facts and vocabulary from your research. Write and perform a Space Exploration Rap.

Google Slides Social

Media Create a series of social media posts as if you were an astronaut or space agency updating the world on an ongoing mission. Include hashtags, descriptive imagery, and visuals. Use one slide for each post you and your team design.

Create a Podcast

Explore the website Anchor to discover how to begin hosting your own podcast shows. Anchor is part of Spotify, and this component is free. Create a podcast and share compelling information you learned while researching space exploration.

Write a Story

Turn your research into a story. Decide on the age level, create characters traveling into space, develop a plot, and create an exciting conclusion. Add some illustrations.

The Sounds of Space Exploration

Listen to Lyrics to Space Oddity. Find 3 other songs about Space Exploration. Select specific lyrics from the songs and write a rationale for why those lyrics connect to your Space Exploration research. Present the lyrics and your rationale in a creative way.

Name _____

Space Exploration Choice Board Rubric

Directions
Refer to the rubric as you work on your project. After the showcase, use the rubric to evaluate your project. Circle the description of each criterion that you think best matches the work on your project and add up the total points. Complete the reflection, then turn in this worksheet.

Criteria	Needs Life Support	A Fly-By of Information	Galaxy of Research	Mission Accomplished
	1	2	3	4
Understanding of Space Exploration Research	The research is limited and unclear.	Displays a basic understanding.	Demonstrates a solid understanding.	Displays an exceptional understanding of the research.
Creativity and Engagement	The project needs more creativity and originality in its presentation.	The project demonstrates limited creativity.	The project is creative and engaging.	The project is innovative and demonstrates exceptional creativity.
Presentation and Communication	The project could be more organized, and the research findings could be more precise.	The research presented is clear and organized but needs more thoroughness.	The project is well organized, and the research findings presented are clear.	The project is well organized and effectively communicates the research findings.
Effort and Enthusiasm	Effort and enthusiasm are minimal.	Participation does not reflect a commitment to the chosen activity and the integration of research.	The project demonstrates a commitment to research and developing a creative project.	The project demonstrates exceptional effort and commitment to researching the topic.
Add Up Points	_____ X 1 = _____	_____ X 2 = _____	_____ X 3 = _____	_____ X 4 = _____
Total Points: _____				

Reflection: What do you think you did well? What would you like to improve?

FUTURE Problem Solving
LESSON PLAN

Should We Invest in Space Exploration or Solve Problems at Home?

R

Objectives

- Students will analyze research to develop key arguments for and against Space Exploration.
- Students will develop collaboration and teamwork skills by working in teams to prepare for the Space Exploration Debate, sharing research, and building cohesive arguments.
- Students will develop critical thinking skills by researching and evaluating diverse perspectives on Space Exploration.
- Students will enhance communication skills by formulating and articulating well-supported arguments.
- Students will develop active listening by engaging with opposing viewpoints and responding to counterarguments.

Standards Addressed
Speaking & Listening
1, 2, 3, 4, 5, 6
Reading & Literacy
1, 2, 3, 4, 7, 8, 10
Writing
1, 4, 5, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

Materials

- **Debate Format Form** (enlarged and posted, see end of Procedures: Part 1)
- Space Exploration articles and visuals from the **Research Bank** on page 12 and the next page, the Future Problem Solving research unit publication, or other sources (see Preparation)
- **Debate Preparation Form**, 1 per student. (page 26)
- **Debate Tracking Sheets**, 1 per student; 2 pages (pages 27-28)
- **Judges' Scoresheet**, 1 for reference plus 1 for each judge – at least 2 judges are recommended (page 29)
- **Space Debate Reflection**, 1 per student (page 30)
- Timer
- Note cards for speakers

Preparation

1. Determine if the debate will be competitive.
2. Determine how debate teams will be formed:
   - Will you allow the students to divide themselves into two teams or will you assign them to a team?
   - Will you use their preference to decide which team they are on or assign teams?
3. Enlarge the **Debate Format Form** to post in the meeting room to record the points awarded during the debate. (See Procedures: Part Three.)
4. Be prepared to appoint a timekeeper when it is time for the debate. This could be a student from one of the debate teams who is not going to be speaking or someone you bring into the classroom.
5. If the debate is competitive, invite several other coaches or administrators to judge it.
6. If you feel students need more than the information in the **Research Bank** for this activity, the articles below are from the Future Problem Solving research unit publication. To purchase this resource, visit fpspimart.org to purchase this unit.
7. When students are close to completing their preparations, plan for and invite at least 2 judges.

FUTURE Problem Solving LESSON PLAN

Should We Invest in Space Exploration or Solve Problems at Home?

R

Research Bank:
Should We Invest in Space Exploration or Solve Problems at Home?

Innovations
What Breakthroughs in Medicine Came from NASA | **Breakthroughs in Medicine**
13 Advanced Space Technologies Improving Our Lives on Earth | **Advanced Space Technology Improving our Lives on Earth:**

Ethical Issues
Six Moral Dilemmas Facing Space Exploration | **Moral Dilemmas**
The Path Forward | **Sustainable Space Exploration**

What Are We Looking For?
Can We Do It? | **Mining in Space**
Exoplanets | **Why We Search**

Pushing the Limits
What Toll Does Space Flights Take on Astronauts? Here's What We Know | **National Geographic**
We Will Never Live in Space: Here's the Reason | **Scientific American**

Standards Addressed
Speaking & Listening
1, 2, 3, 4, 5, 6
Reading & Literacy
1, 2, 3, 4, 7, 8, 10
Writing
1, 4, 5, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

Procedure

	PART ONE: INTRODUCTION TO DEBATE
1	**Say:** *Debate can be a fun way to explore all the sides of an issue.*
2	**Discuss:** *Have any of you ever participated in a debate before or taken a stance and debated an issue with your friends?*
3	**Say:** *We will be debating the value of Space Exploration. Should we continue to invest in exploring the universe or focus on solving Earth's challenges?*
4	Introduce the debate key question: • Is space exploration worth the cost?
5	**Say:** *We will need two teams for our debate: Pro Space Exploration: Yes, space exploration is worth the cost, and Anti Space Exploration: No, space exploration is not worth the cost.* Explain how teams will be chosen.
6	**Say:** *Within your debate team, you will assign the following speaking roles.* • Opening speaker who makes your opening statement • Rebuttal speaker who speaks against what the opposing team said in their opening statement • Closing speaker who makes your closing arguments
7	**Say:** *Even though there are only 3 speakers for each team, ALL team members are responsible for planning the debate, taking notes during the debate, and consulting during the debate.*

FUTURE Problem Solving LESSON PLAN

Should We Invest in Space Exploration or Solve Problems at Home?

R

Procedure part one, continued

Standards Addressed
Speaking & Listening
1, 2, 3, 4, 5, 6
Reading & Literacy
1, 2, 3, 4, 7, 8, 10
Writing
1, 4, 5, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

PART ONE: INTRODUCTION TO DEBATE	
8	Call attention to the **Debate Format Form** you posted in the meeting space. As you review how the debate will proceed, refer to the **Judge's Scoresheet** so you can tell students what the judges will be looking for and how many points they can earn for each section.
9	**Say:** *I want to remind you that even though some of you will be arguing against going into space, this would probably not be a good approach to take with the future scene for the actual booklet! It might be relevant to cite a challenge related to some people objecting to space exploration, but to choose an underlying problem like '…in what ways might we stop space exploration…' will more than likely deny the future scene, which is a critical error that results in a huge point loss. You must work with the future scene, accepting what it says and trying to improve it, not stop it from happening.*

Debate Format Form	**Time**	**Points Awarded** (totals from all judges)	
		Team 1	**Team 2**
Opening Statements: Each team presents their main arguments.	5 minutes (each)		
Rebuttals: The team refutes the opposing team's arguments, addressing specific points made in the opening statements.	5 minutes (each)		
Closing Statements: Each team summarizes their arguments, emphasizing why their stance is the most logical.	3 minutes (each)		
Open Floor Discussion: Open the floor for additional observers to ask questions or present additional points – no points awarded.	5 – 10 minutes	**Total**	**Total**

PART TWO: DEBATE PREPARATION	
1	Distribute the **Debate Preparation Form**.
2	**Say:** *Each team will meet together to prepare for the debate and identify supportive research for the issue you are defending.* Discuss the following:
3	The Pro-Space Exploration team may focus on topics such as: • Space exploration is worth the cost. • The benefits of scientific discoveries • Economic opportunities • New resources • Long-term survival of humankind

FUTURE Problem Solving LESSON PLAN

Should We Invest in Space Exploration or Solve Problems at Home?

R

Procedure part two, continued

PART TWO: DEBATE PREPARATION	
4	The Anti-Space Exploration Team may focus on topics such as: • Space exploration is not worth the cost. • High cost in money and resources • Harm to environments and/or humans (such as astronauts/cosmonauts/taikonauts, paying space travelers) • Ethical issues of colonization • Prioritizing earth-based problems
5	**Say:** *Each team will organize the data from their research into a logical sequence and prepare their presentation to defend their stance. Speakers may use notecards to remember important points. Your team may prepare visuals to accompany your presentation during the debate – graphs, charts, pictures, etc. There are three times to speak:* • *Opening Statements/Arguments (5 minutes)* • *Rebuttals: (Preparation time plus 5 minutes for rebuttal)* • *Closing Statements (Preparation time plus 3 minutes for closing statement)*
6	Discuss with students where they can find more research information if needed.
7	Prepare and practice the presentations.

PART THREE: THE DAY OF THE DEBATE	
1	To make this a memorable event: • Encourage students to dress professionally. • Arrange the room for the debate: You may want to use a podium for the speakers. • Invite special guests.
2	Share the judges' form and instructions with the judges.
3	Distribute the **Debate Tracking Sheet** and review the instructions with teams.
4	Introduce the judges. Distribute the **Judges' Scoresheet** and give them a few minutes to look over the form and ask any necessary questions.
5	Introduce the members of each debate team and announce their role in the debate: speaker or team support.
6	Introduce the timekeeper.
7	Conduct the debate.

Closure

1. Discuss the key points made in the debate.
2. Highlight strong examples of good arguments. (Students, judges, and coach may contribute.)
3. Highlight strong points of teamwork. (Students, judges, and coach may contribute.)
4. Thank the judges.
5. Team members will complete the **Debate Reflection** individually.

Standards Addressed
Speaking & Listening
1, 2, 3, 4, 5, 6
Reading & Literacy
1, 2, 3, 4, 7, 8, 10
Writing
1, 4, 5, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

Name _____

Debate Preparation Form - Opening Statement

Directions: Use this chart as you research to collect data and examples to support your arguments and develop your opening statement. Look for supporting evidence. You will use the chart to develop the first 5-minute speech that opens the debate and presents your case.

Argument	Evidence (Facts, Statistics, Example)

Name _____

Debate Tracking Sheets - Rebuttals

Directions

1. Use this chart to record key points made during the debate by the opposing team.
2. This will help you to prepare for the 5-minute rebuttal.

Key Point Made	Rebuttals/Counterpoints

Name _____

Debate Tracking Sheets - Closing Statement

Directions

1. Use this chart to plan your 3-minute closing statement.
2. Summarize your main points. Emphasize why your points are the most logical. Use clear reasoning.

Key point made	Why it is the most logical

Name _____

Judges' Scoresheet

Directions

Thank you for judging our Space Exploration debate! The two sides of the debate are:

- Pro Space Exploration: Yes, space exploration is worth the cost.
- Anti Space Exploration: No, space exploration is not worth the cost.

The goal for you is to help select the winning team! Between every statement, there will be time for teams to get ready for the next one and for you to determine the score for that statement. When you have determined points, please alert the emcee so the total points so far can be recorded in the debate chart.

Debate Format	Time	Points Awarded (totals from all judges)	
		Team 1	Team 2
Opening Statements Each team presents their main arguments. Listen for clear reasoning and evidence. Award from 10 to 20 points.	5 minutes (each)		
Rebuttals The team refutes the opposing team's arguments, addressing specific points made in the opening statement. Did the team listen to the opposing Opening Statement and rebut appropriately? Award from 5 to 15 points.	5 minutes (each)		
Closing Statements Each team summarizes their arguments, emphasizing why their stance is the most logical. Listen for clear reasoning in the summation. Award from 5 to 15 points.	3 minutes (each)		
Open Floor Discussion Open the floor for additional observers to ask questions or present additional discussion points. No points awarded. Total each teams' points.	5 – 10 minutes	**Total**	**Total**

Name _____

Space Debate Reflection

What is something new you learned from your participation in the debate? Did your perspective change after hearing both sides of the issue?

What was challenging?

Were there areas your team could improve such as critical thinking, preparation, delivery?

FUTURE Problem Solving LESSON PLAN

Generating Challenges

R STEP 1

Objectives

- Students will analyze specific scenarios related to space exploration and identify potential challenges based on those scenarios.
- Students will generate diverse challenges using the Categories List.
- Students will collaborate in small teams to develop Fluency and Flexibility in challenge identification.

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 2, 3, 4, 7
Writing
7, 9
Language & Vocabulary
1, 2, 3

Materials

- **Challenge Mission Log**, 1 per team if forming 6 teams, 2 per team if forming 3 teams. See Preparation (page 33)
- **Mission Cards,** 1 different card per team. (pages 34-35)
- **Categories List,** 1 per team if students don't already have their own copy (download a pdf here or display it so all students can see)

Preparation

1. There are 6 different mission cards. If you can, divide the students into 6 teams. If not, divide the students into 3 teams and give each team 2 mission cards.
2. Photocopy the **Mission Cards** and cut them out.

Procedure

PART ONE: INTRODUCTION TO MISSION CONTROL	
1	**Say:** *Welcome to Mission Control! NASA has requested your expertise in Space Exploration to help identify challenges related to some new initiatives they are launching. Today, your teams will help them out by brainstorming challenges that might occur.*
2	Divide the class into teams as determined above.
3	Distribute the **Challenge Mission Log.**
4	**Say:** *I have several **Mission Cards**, each containing one of the situations NASA is concerned about. Your job will be to read the Mission Card as a team and identify as many challenges as possible that could unfold from the situation. Log your challenge ideas in your **Mission Log**, along with the category related to it. Remember—brainstorming various challenges in different categories will be the most helpful to NASA!*
5	Distribute the **Mission Cards** as determined by the number of teams.
6	Provide work time.

Coaching Tip

Use additional Resource Library Categories List tools like the poster and one-pager with all the definitions to help students learn and utilize the Future Problem Solving Categories List to generate challenges.

Generating Challenges

Procedure, continued

PART TWO: SHARING THE BRAINSTORMING	
1	**Say:** *Now that you've brainstormed challenges related to your missions, let's see what ideas you'll present to NASA.*
2	Each team will read their **Mission Card** and share the challenge ideas they brainstormed and the categories they fit into.
3	As each team presents, ask the students to consider what other challenges might relate to each **Mission Card** situation. This collaborative effort will help students see more possibilities and refine their thinking.

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 2, 3, 4, 7
Writing
7, 9
Language & Vocabulary
1, 2, 3

Closure

1. **Say:** *You did an awesome job coming up with a variety of challenges for all these situations. Remember that while some future scenes will have very obvious challenges, using the **Categories List** in your brainstorming is important—this will impress the judges and earn you more flexibility points!*
2. Ask the class which **Mission Card** situation was the hardest for coming up with many challenges. Have each team share the strategies they used to tackle the difficulties of their situations with the class.
3. **Say:** *Great work using the challenge brainstorming process and applying it to the scenarios in Mission Control. Space Exploration is a complex topic, so it's important to consider multiple categories to ensure that every area of the future scene is included!*

Name _____

Challenge Mission Log

Directions: Use the log below to record each challenge you brainstorm and the category it comes from. If you need more room, write on the back of this page.

Category	Challenge idea

Name _____

Mission Cards

MISSION CARD
Cosmic crops

Your team is part of a mission tasked with developing new food production systems on the International Space Station (ISS). You are exploring the possibility of using cosmic radiation to alter crops, similar to techniques used in the Space Race that led to breakthroughs in agriculture on Earth. However, there are concerns about how this process might affect astronauts' health and whether the crops will thrive in space conditions.

MISSION CARD
Contamination situation

Your team is preparing to launch a crewed mission to Mars, but environmentalists and ethicists are raising concerns. They worry about the contamination of Mars' environment with Earth-based microbes and the ethical implications of establishing human colonies on another planet. Some argue that we should focus on fixing problems on Earth before expanding to other planets.

MISSION CARD
That one's MINE!

Your team is leading a deep-space mission to explore a distant exoplanet in the habitable zone. While some scientists hope to find signs of life, your funding is partially coming from private companies interested in mining valuable minerals from the planet's surface. You must balance scientific goals with the commercial interests of your sponsors.

Page 1 of 2 →

Name _____

Mission Cards

MISSION CARD
Go the distance

Your mission is to send a crew to the outer edge of our solar system to explore planets and moons that are far beyond where humans have ever gone. This mission will take years, and astronauts will face prolonged exposure to radiation, isolation, and the effects of microgravity. The technology needed for such a long journey is also still experimental.

MISSION CARD
Space junk slam

Your team is working on a space mission to collect and remove space debris from Earth's orbit. The increasing amount of debris from satellites, rockets, and space stations poses a threat to future space missions and the ISS. However, removing debris is expensive and requires precise technology that has not been fully tested yet.

MISSION CARD
Moving to the Moon

Your team has been asked to design a space habitat for long-term human habitation on the Moon. Many technologies from the Space Race-such as insulation materials and water purification systems
-are available, but they need significant upgrades to support permanent settlements in the extreme lunar environment.
Sustainable systems for energy, air, and water are also lacking.

FUTURE Problem Solving LESSON PLAN

Writing Challenges

FS STEP 1

Objectives

- Students will distinguish relevant, properly structured challenges from irrelevant, vague, or improperly formatted challenges.
- Students will identify common errors in written challenges.
- Students will correctly rewrite relevant challenges that are improperly formatted or have errors.
- Students will build teamwork by completing the challenge analysis activity as a team.

Standards Addressed
Speaking & Listening
1, 2, 3, 4, 6
Reading & Literacy
1, 2, 3, 4, 5, 7, 8, 10
Writing
1, 2, 4, 5, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

Materials

- **StellaForge Technologies Development Brief,** 1 per team; 2 pages (pages 38-39)
- **Identifying Challenges Activity,** 1 per team; 3 pages (pages 40-42)
- **Identifying Challenges Activity – Answer Key**, 1 for coach reference; 2 pages (pages 43-44)

Preparation

1. Be prepared to display the suggested template for challenge writing. See Procedure Part One, #5.

Procedure

PART ONE	
1	**Say:** *Today, we have an important job as Future Problem Solvers. StellaForge Technologies, a rising leader in aerospace technology, is introducing a groundbreaking innovation that could revolutionize space exploration. However, the public is concerned about a number of possible challenges related to this development.*
2	**Say:** *The CEO of StellaForge has called on you to help identify which of these challenges are realistic and properly written before she sends them on to the team working on this technology. Your responses could determine how well their team approaches the potential pitfalls of this innovation.*
3	**Say:** *But before we explore the information they've sent, who can explain the components of a challenge?*
4	Student responses may include the following. Be prepared to point out anything missing in their responses. • States what the challenge is and explains why it is a challenge • Is clearly written • Shows cause and effect • Includes research and vocabulary from both the research and the future scene • Avoids extreme language and absolutes • Uses hypothetical language like "may," "might," and "could" • The challenges incorporate different categories
5	Write the formula below on the board to show students a correct format for challenges. a. Since/Because <u>fact/cause from the future scene</u>, <u>effect</u> may/might/could happen. This could result in <u>consequence of the cause/effect that would be a problem.</u>

Procedure one, continued

PART ONE	
6	**Say:** *Every challenge must have a cause, an effect, and a consequence. This formula is one way to show those three parts.*
7	**Say:** *Now let's examine StellaForge Technologies' project and see what's next.*
8	Distribute **StellaForge Technologies Development Brief** and read it together.
9	**Say:** *Wow. This sounds like an intense project with a lot of potential, but there are also many things the team needs to iron out! This is definitely a job for the Future Problem Solvers. Work in your teams to identify the challenges that fit the Future Problem Solving challenge criteria and rework the ones that do not.*
10	Distribute **Identifying Challenges Activity.**

PART TWO	
1	Review the teams' responses to the challenges. Some rewrites may have different answers, so offer multiple teams the chance to share.
2	Discuss how evaluating challenges this way can help with writing challenges during the production of a Future Problem Solving booklet.

Standards Addressed
Speaking & Listening
1, 2, 3, 4, 6
Reading & Literacy
1, 2, 3, 4, 5, 7, 8, 10
Writing
1, 2, 4, 5, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

Closure

1. Ask the students what their Future Problem Solving team can do to ensure that their challenges are correctly written.
2. **Say:** *Great job reviewing the rules for writing challenges! Remember that well-written challenges are essential to fully understanding the scope of the problem in Future Problem Solving, as they help us think critically about what needs to be solved.*

Stellaforge Technologies Development Brief

Space Exploration – **Challenge Chaos** *(Topic Activity Unit)*

To: Future Problem Solvers
From: Maxine Orion, CEO, StellaForge Technologies
Development Brief: Plasma-Fusion Propulsion System
STRICTLY CONFIDENTIAL

Dear Future Problem Solvers,

I am thrilled to share with you the official launch of our Plasma-Fusion Propulsion System (PFPS), a monumental leap forward in space exploration technology. After years of research, development, and overcoming countless challenges, StellaForge Technologies has finally achieved what many in the industry thought impossible: a propulsion system capable of transforming how we travel through space.

Overview of PFPS:
The Plasma-Fusion Propulsion System harnesses advanced plasma and fusion technology to create thrust that far surpasses any conventional rocket engine in both speed and efficiency. PFPS is designed for deep-space missions, offering a sustainable, high-speed solution for interplanetary travel. Below are key features of this groundbreaking innovation:

1. Unprecedented Speed:
With PFPS, spacecraft will be able to travel at speeds 10 times faster than current chemical propulsion systems. For comparison, journeys to Mars that currently take 6-9 months will be reduced to just two weeks. This revolutionizes manned and unmanned missions and opens the door to space tourism, asteroid mining, and more frequent exploration of distant celestial bodies.

2. Fusion-Powered Efficiency:
A controlled fusion reaction at the heart of the system generates plasma—the fourth state of matter—creating thrust. Unlike traditional chemical rockets that burn fuel and create massive amounts of waste, PFPS operates on hydrogen isotopes that fuse to produce immense quantities of energy with very little fuel. This results in longer mission durations without the need to constantly refuel.

3. Sustainability and Lower Environmental Impact:
PFPS is a cleaner alternative to chemical rockets, producing minimal emissions. By using plasma and fusion, we are reducing the carbon footprint of launches, positioning StellaForge as a leader in sustainable space exploration. Additionally, the system uses renewable resources such as hydrogen, making it far more environmentally friendly than traditional methods.

Parameters

Time:

Place:

Topic:

WARNING:
This is not an official future scene. DO NOT USE this future scene for your Practice Problem 2 Space Exploration submission.

Page 1 of 2 ⟶

4. Durability for Extended Missions:
One of the core advantages of PFPS is its ability to support long-term, deep-space missions. The propulsion system is engineered to function for extended periods without significant degradation, allowing spacecraft to travel beyond our solar system with minimal wear and tear. This makes it ideal for ambitious missions to the outer planets and beyond.

With PFPS, StellaForge Technologies is leading humanity into a new era of space exploration. We anticipate that by 2045, PFPS will not only make interplanetary travel routine but also enable long-distance missions to moons like Europa and Titan and potentially even exoplanets in neighboring star systems.
This is more than just an innovation—it's the next step in expanding our reach beyond Earth and into the cosmos. Together, we will shape the future of space exploration and unlock possibilities once confined to science fiction.

Our team has assembled the following list of challenges that we foresee as part of the PFPS. Please review them and identify challenges describing how we can better focus on the potential pitfalls of this exciting development.

Thank you for your dedication and belief in this vision. The stars are now within our grasp.

Sincerely,

Maxine Orion
CEO, StellaForge Technologies

WARNING:
This is not an official future scene. DO NOT USE this future scene for your Practice Problem 2 Space Exploration submission.

Name _____

Identifying Challenges Activity

Directions

1. Read the following challenges assembled by StellaForge Technologies related to their new Plasma-Fusion Propulsion System.
2. Determine which challenge ideas are correctly written and which need revision. If you check 'needs revision,' make a recommended revision in the box. If the challenge is not relevant, your revision can be a different challenge idea.

Challenge One

Due to the high speed of the Plasma-Fusion Propulsion System (PFPS), space debris collisions may become more frequent, increasing the likelihood of damage to spacecraft in orbit. This may be a challenge because spacecraft in orbit will be at greater risk of being decimated in a ball of fire.

☐	**Correctly written (Scored YES)**
☐	**Needs revision (Scored perhaps, why, solution, or duplicate)**

Revision

Challenge Two

The Plasma-Fusion Propulsion System is too expensive.

☐	**Correctly written (Scored YES)**
☐	**Needs revision (Scored perhaps, why, solution, or duplicate)**

Revision

Name _____

Identifying Challenges Activity

Challenge Three

Because StellaForge's propulsion system emits high radiation levels, nearby spacecraft could be at risk of radiation exposure. This may be a challenge because it could lead to equipment malfunctions or health hazards for astronauts, which could pose obstacles for future space missions.

☐	**Correctly written (Scored YES)**
☐	**Needs revision (Scored perhaps, why, solution, or duplicate)**

Revision

Challenge Four

The StellaForge Technologies break room doesn't have any donuts. This could be a challenge because we might not have anything to eat while we work on the PFPS.

☐	**Correctly written (Scored YES)**
☐	**Needs revision (Scored perhaps, why, solution, or duplicate)**

Revision

Name _____

Identifying Challenges Activity

Challenge Five

The Plasma-Fusion Propulsion System might cause tension between private space companies and governments.

☐	**Correctly written (Scored YES)**
☐	**Needs revision (Scored perhaps, why, solution, or duplicate)**

Revision

Challenge Six

Due to StellaForge Technologies' dominance in the market, smaller space exploration companies may struggle to compete, potentially leading to a monopoly in space exploration. This may be a challenge because it could stifle innovation and limit access to space resources.

☐	**Correctly written (Scored YES)**
☐	**Needs revision (Scored perhaps, why, solution, or duplicate)**

Revision

FUTURE Problem Solving
ANSWER KEY

Identifying Challenges Activity

STEP 1

Challenge One

Due to the high speed of the Plasma-Fusion Propulsion System (PFPS), space debris collisions may become more frequent, increasing the likelihood of damage to spacecraft in orbit. This **will** be a challenge because spacecraft in orbit **will** be **at greater risk of being decimated in a ball of fire.**

NEEDS REVISION: Uses extremes and absolute language.

Possible Revision: Due to the high speed of the Plasma-Fusion Propulsion System (PFPS), space debris collisions may become more frequent. This **may** be a challenge because spacecraft in orbit could **put astronauts and equipment at risk**.

Challenge Two

The Plasma-Fusion Propulsion System is too expensive.

NEEDS REVISION: Does not state why it is a challenge, does not use hypothetical language

Possible Revision: Due to the high development costs of the Plasma-Fusion Propulsion System, only wealthy nations and corporations may have access to deep-space exploration. This may be a challenge because it could increase inequality in space access and limit innovation.

Challenge Three

Because StellaForge's propulsion system emits high levels of radiation, nearby spacecraft could be at risk of radiation exposure. This may be a challenge because it could lead to equipment malfunctions or health hazards for astronauts, which could pose obstacles for future space missions.

CORRECTLY WRITTEN

FUTURE Problem Solving ANSWER KEY

Identifying Challenges Activity

STEP 1

Challenge Four

The StellaForge Technologies break room doesn't have any donuts. This could be a challenge because we might not have anything to eat while we work on the PFPS.

NEEDS REVISION: This challenge is an extreme. It would be scored Perhaps or Why

Possible Revision: Students may choose a relevant area of the PFPS brief to focus on and write a correct challenge.

Challenge Five

The Plasma-Fusion Propulsion System will cause tension with the government.

NEEDS REVISION: Does not state why it is a challenge; too broad; uses absolute language.

Possible Revision: Due to the unprecedented speed and range of the Plasma-Fusion Propulsion System (PFPS), StellaForge Technologies may inadvertently violate provisions of the Outer Space Treaty, which prohibits any nation or entity from claiming sovereignty or exploiting resources in space. This may be a challenge because conflicts over territorial rights and resource extraction could arise, leading to international disputes and legal barriers that may hinder future space missions.

Challenge Six

Due to StellaForge Technologies' dominance in the market, smaller space exploration companies may struggle to compete, potentially leading to a monopoly in space exploration. This may be a challenge because it could stifle innovation and limit access to space resources.

CORRECTLY WRITTEN

FUTURE Problem Solving LESSON PLAN

Finding the Right Focus for Underlying Problems

T STEP 2

Objectives

- Students will apply their knowledge of the components of an underlying problem to deepen their understanding of the root causes of complex issues.
- Students will identify common themes among challenges.
- Students will collaborate to write underlying problems in the proper format.

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 2, 4, 7, 10
Writing
1, 2, 4, 5, 7, 10
Language & Vocabulary
1, 3

Materials

- **Set #1,** 1 for each team using this set; see Preparation; 2 pages. (pages 47-48)
- **Set #2,** 1 for each team using this set; 2 pages. (pages 49-50)
- **Set #3**, 1 for each team using this set; 2 pages. (pages 51-52)
- **Set $4**, 1 for each team using this set; 2 pages. (pages 53-54)
- **Underlying Problem Suggestions,** 1 for coach reference. (page 55)

Preparation

1. Divide the students into at least 4 groups so that each group can work on a different theme. Groups should have 2, 3, or 4 members. If necessary, several groups can work on the same theme.

Procedure

PART ONE: UNDERLYING PROBLEM REVIEW	
1	**Say:** *Today, we will practice developing underlying problems based on a set of challenges. Remember that your underlying problem will set the stage for your solutions and action plan in the Future Problem Solving process. That means you need to be able to identify the most significant issue in your challenges so you can make the best choice.*
2	Review the requirements for an underlying problem: • Based on a significant issue related to the future scene, especially the future scene charge • **Condition phrase** tells what's happening that creates this problem. • **Stem:** How might we... or In what ways might we… • **Key verb phrase (KVP):** The central action, using only one verb modifying only one object. • **Purpose** tells why you want to solve this problem. • **Parameters:** The time, place, and topic of the future scene
3	**Say**: *In this activity, you will be given a list of challenges related to space exploration. Your task will be to look at the challenges, determine a significant issue for your theme, and write an underlying problem related to that issue. Consider the research you have completed and what you know about space exploration to make your decision. For this activity, there is no future scene, so your condition phrase should be based on a significant issue related to your topic research. Use 2025 for the time and space as the place. At the end of the activity, you'll be sharing your underlying problems and how you selected them.*
4	**Distribute** the **Underlying Problem Exploration Activity Sheets** so that at least one group is working on each theme.
5	Review the directions and provide work time.

Finding the Right Focus for Underlying Problems

Procedure, continued

PART TWO	
1	Each team will present how they selected their underlying problem. • What challenges pointed them to the idea for their underlying problem? • Share their team discussion on how they decided on the condition phrase, key verb phrase, and purpose. What were the options discussed?
2	**Say:** *Can anyone identify connections between the different underlying problems presented? Are any of the underlying problems interrelated? For example, an underlying problem about propulsion technology could connect with an underlying problem about human survival in space.*
3	**Say**: *Remember, when you complete the Future Problem Solving process for the competition, you'll be working with a set of challenges your team has written related to the future scene. What might help you to identify the full 16 challenges?* Possible answers may include: • The **Categories List** • Research completed before the competition • Original challenges directly related to information in the future scene • Thinking about what challenges can be based on the future scene charge

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 2, 4, 7, 10
Writing
1, 2, 4, 5, 7, 10
Language & Vocabulary
1, 3

Closure

1. **Say:** *Good work identifying underlying problems based on these challenges. Recognizing common themes among your challenges will be an important skill for selecting a relevant, impactful issue for your underlying problem.*
2. **Say:** *Does anyone have questions related to this critical step of the Future Problem Solving process?*

Name _____

Set #1

Directions

1. Review the following challenges in your team's set of challenges.
2. Look for common issues for the focus of your team's underlying problem.
3. Identify challenges that helped you identify your underlying problem. Mark each one with an X.
4. If you see challenges that are irrelevant, draw a line through them.

	CHALLENGES
	Muscle and bone loss: Astronauts experience muscle atrophy and bone density loss due to prolonged exposure to low gravity, making it difficult to maintain physical health during long-term space missions.
	Radiation exposure: Space travelers are exposed to higher levels of cosmic radiation outside Earth's atmosphere, which increases the risk of cancer and other health issues.
	Psychological stress: Extended isolation and confinement in space can lead to significant psychological stress, affecting mental health and cognitive function.
	Lack of natural resources: Space habitats must rely on limited, imported resources (like water, oxygen, and food), making long-term self-sufficiency extremely challenging.
	Alien contamination risk: There is a concern about potential exposure to alien microorganisms that could pose unknown health risks to humans.
	Space suits and equipment failures: Space suits and life support systemsoccasionally malfunction, and equipment failures in space can have catastrophic consequences for survival.
	Radiation shielding for spacecraft: Developing effective shielding against radiation is a significant technological hurdle, especially for long-duration missions.
	Solar storms and space weather: Astronauts are vulnerable to solar storms, which could disrupt electronics and pose life-threatening radiation risks during extravehicular activities (EVAs).
	Interpersonal conflicts: Being confined in a small space for extended periods can lead to interpersonal conflicts, which might affect teamwork and decision-making, especially during high-stress situations.
	Spaceship malfunctions: Occasionally, mechanical systems like navigation and communication fails in space, leading to dangerous situations.

Name _____

Set #1

Directions

1. Write your team's underlying problem in the space below.
2. After writing your underlying problem, review the guidelines below to ensure you have followed the requirements for a correctly written underlying problem.

OUR UNDERLYING PROBLEM

Underlying problem guidelines review

- An underlying problem is based on **a significant, important issue** connected to the topic or the future scene.
- The focus of an underlying problem **is narrowed**. It must not restate or broaden the topic or future scene.
- It must use **non-absolute verbs**, such as increase, decrease, improve, maximize, or minimize.

An underlying problem must include all components:

- **Condition phrase**
- **Stem & key verb phrase (only one verb)**
- **Purpose**
- **Parameters (time, topic, place)**

Use the formula below to write your underlying problem:
Since/Because fact from the future scene, how might we key verb phrase so that purpose?

Name _____

Set #2

Directions:

1. Review the following challenges in your team's set of challenges.
2. Look for common issues for the focus of your team's underlying problem.
3. Identify challenges that helped you identify your underlying problem. Mark each one with an X.
4. If you see challenges that are irrelevant, draw a line through them.

	CHALLENGES
	Long travel times: Current propulsion systems are too slow for deep space exploration, taking months or even years to reach distant planets like Mars or beyond.
	Orbital launch costs: The cost of launching spacecraft into orbit remains high due to expensive launch systems like rockets.
	Fuel efficiency: Spacecraft propulsion systems require enormous amounts of fuel, which limits the distance they can travel without refueling and increases mission costs.
	Cost of space travel: The high cost of current propulsion systems and space travel technology makes space exploration accessible only to a few wealthy nations and organizations.
	Limited propulsion technology: The lack of advanced propulsion technologies, such as nuclear propulsion or ion drives, limits humanity's ability to travel to distant planets or solar systems.
	Weight of propellant: Carrying large amounts of fuel adds significant weight to spacecraft, reducing payload capacity and increasing the complexity of mission planning.
	Space debris (Outlier): Space debris poses a constant threat to spacecraft during travel, as collisions with debris can damage the craft and disrupt missions.
	Radiation exposure during travel: Astronauts are exposed to harmful cosmic radiation during long-term space travel, which is a significant health risk.
	Lack of refueling infrastructure: There are no refueling stations or infrastructure for long-distance space travel, making extending missions beyond what the spacecraft can initially carry impossible.
	Communication delays: Communication delays between spacecraft and Earth increase as distances grow, making it harder to control or receive data in real-time.

Name _____

Set #2

Directions

1. Write your team's underlying problem in the space below.
2. After writing your underlying problem, review the guidelines below to ensure you have followed the requirements for a correctly written underlying problem.

OUR UNDERLYING PROBLEM

Underlying problem guidelines review

- An underlying problem is based on **a significant, important issue** connected to the topic or the future scene.
- The focus of an underlying problem **is narrowed**. It must not restate or broaden the topic or future scene.
- It must use **non-absolute verbs**, such as increase, decrease, improve, maximize, or minimize.

An underlying problem must include all components:

- **Condition phrase**
- **Stem & key verb phrase (only one verb)**
- **Purpose**
- **Parameters (time, topic, place)**

Use the formula below to write your underlying problem:
Since/Because fact from the future scene or related research, how might we key verb phrase so that purpose?

Name _____

Set #3

Directions

1. Review the following challenges related to your team's assigned theme.
2. Look for common issues for the focus of your team's underlying problem.
3. Identify challenges that point to a possible theme for the underlying problem. Mark each with an X.
4. If you see challenges that are irrelevant, draw a line through them.

	CHALLENGES
☐	**Political and legal barriers:** International laws and regulations regarding the exploration and use of resources on other planets remain unclear, potentially leading to disputes or delays in missions.
☐	**Lack of interest from private companies:** Private companies are less interested in funding planetary exploration missions due to the high cost and lack of immediate returns, which may divert attention from the technological and logistical challenges of planetary exploration.
☐	**Harsh environments:** Many planets and moons, like Mars and Europa, have extreme temperatures, lack breathable atmospheres, and are subject to intense radiation, making human exploration difficult.
☐	**Drilling and surface exploration:** It's challenging to drill beneath the surface of planets or moons, such as the thick ice sheets on Europa, to search for water or life.
☐	**Limited knowledge of planetary resources:** We don't have sufficient information about the types and quantities of resources (e.g., water, minerals) available on other planets.
☐	**Landing on unstable surfaces:** Some planets and moons have surfaces that are unstable or difficult to land on safely, which increases the risk of damage to spacecraft or rovers.
☐	**Communication delays:** As exploration moves further from Earth, communication delays increase, making it difficult to control rovers or receive real-time data.
☐	**Energy sources for exploration:** Spacecraft and rovers face limitations in energy supply. Solar energy isn't always viable on distance planets, and we lack efficient long-lasting energy solutions for planetary exploration.

Name _____

Set #3

Directions

1. Write your team's underlying problem in the space below.
2. After writing your underlying problem, review the guidelines below the box to ensure you have followed the requirements for a correctly written underlying problem.

OUR UNDERLYING PROBLEM

Underlying problem guidelines review

- An underlying problem is based on **a significant, important issue** connected to the topic or the future scene.
- The focus of an underlying problem **is narrowed**. It must not restate or broaden the topic or future scene.
- It must use **non-absolute verbs**, such as increase, decrease, improve, maximize, or minimize.

An underlying problem must include all components:

- **Condition phrase**
- **Stem & key verb phrase (only one verb)**
- **Purpose**
- **Parameters (Time, Topic, Place)**

Use the formula below to write your underlying problem:
Since/Because fact from the future scene or related research, how might we key verb phrase so that purpose?

Name _____

Set #4

Directions

1. Review the following challenges related to your team's assigned theme.
2. Look for common issues for the focus of your team's underlying problem.
3. Identify challenges that point to a possible theme for the underlying problem. Mark each with an X.
4. If you see challenges that are irrelevant, draw a line through them.

CHALLENGES	
☐	**Harsh environments:** Many planets and moons, like Mars and Europa, have extreme temperatures, lack breathable atmospheres, and are subject to intense radiation, making human exploration difficult.
☐	**Political and legal barriers:** International laws and regulations regarding the exploration and use of resources on other planets remain unclear, potentially leading to disputes or delays in missions.
☐	**Drilling and surface exploration:** It's challenging to drill beneath the surface of planets or moons, such as the thick ice sheets on Europa, to search for water or life.
☐	**Limited knowledge of planetary resources:** We don't have sufficient information about the types and quantities of resources (e.g., water, minerals) available on other planets.
☐	**Potential contamination:** There's concern about contaminating planets with Earth-based organisms, which could interfere with the discovery of alien life or change the environment of the planet.
☐	**Landing on unstable surfaces:** Some planets and moons have surfaces that are unstable or difficult to land on safely, which increases the risk of damage to spacecraft or rovers.
☐	**Communication delays:** As exploration moves further from Earth, communication delays increase, making it difficult to control rovers or receive data in real time.
☐	**Energy sources for exploration:** Spacecraft and rovers face limitations in energy supply. Solar energy isn't always viable on distant planets, and we lack efficient long-lasting energy solutions for planetary exploration.
☐	**Difficulty in transporting equipment:** Sending large, complex equipment like habitats, drilling rigs, or mining tools to other planets is extremely expensive and requires advanced logistical solutions.
☐	**Lack of interest from private companies:** Private companies are less interested in funding planetary exploration missions due to the high cost and lack of immediate returns, which may divert attention from the technological and logistical challenges of planetary exploration.

Name _____

Set #4

Directions

1. Write your team's underlying problem in the space below.
2. After writing your underlying problem, review the guidelines below the box to ensure you have followed the requirements for a correctly written underlying problem.

OUR UNDERLYING PROBLEM

Underlying problem guidelines review

- An underlying problem is based on **a significant, important issue** connected to the topic or the future scene.
- The focus of an underlying problem **is narrowed**. It must not restate or broaden the topic or future scene.
- It must use **non-absolute verbs**, such as increase, decrease, improve, maximize, or minimize.

An underlying problem must include all components:

- **Condition phrase**
- **Stem & key verb phrase (only one verb)**
- **Purpose**
- **Parameters (time, topic, place)**

Use the formula below to write your underlying problem:
Since/Because fact from the future scene or related research, how might we key verb phrase so that purpose?

Name _____

Underlying Problem Suggestions

The following underlying problems could relate to several different sets of challenges.

Because astronauts may experience physical changes and possible harm to their bodies during space exploration, how might we improve the maintenance of their physical health of the astronauts so they will be able to fulfill their mission in 2026 and beyond?

Because astronauts are confined in small spaces with other astronauts and away from their families for extended periods of time during space exploration, in what ways might we promote the mental well-being of the astronauts so they will be able to complete their mission in 2026 and beyond?

Because there are no refueling stations or infrastructure for long-distance space travel, making extending missions beyond what the spacecraft can initially carry impossible, how might we increase the number of supply stations in our solar system so that space exploration in our solar system will become more possible in 2026 and beyond?

Because current propulsion systems are too slow and require too much fuel for deep space exploration, how might we increase the development of advanced propulsion technologies in 2026 and beyond so that extended missions into space may become possible?

Because international laws and regulations regarding the exploration and use of resources on other planets remain unclear, in what ways might we maximize cooperation among space exploration organizations so that fewer disputes will arise in 2026 and beyond?

Because private companies are less interested in funding planetary exploration missions due to the high cost and lack of immediate returns, how might we maximize cooperative participation in space exploration missions so that space can become a positive resource for all humankind in 2026 and beyond?
Alternate Purpose: so that no one organization has to bear the full cost of a mission?

Because we don't have sufficient information about the types and quantities of resources (e.g., water, minerals) available on other planets or asteroids, how might we increase our knowledge of what resources might be available in space so that costly space exploration missions can be targeted for what is needed in 2026 and beyond?

Because there is concern about contaminating planets with Earth-based organisms, which could interfere with the discovery of alien life or change the environment of the planet, in what ways might we support the development of guidelines for space exploration so that Earth's space missions are less likely to harm the living environments of other space bodies in 2026 and beyond?

FUTURE Problem Solving
LESSON PLAN

An Authentic Space Exploration Challenge

M STEP 1 STEP 2 STEP 3

Objectives

- Students will apply their knowledge of the solution writing format.
- Students will develop critical and creative thinking skills by participating in a Design Thinking Challenge, producing a solution to the problem presented.

Standards Addressed
Speaking & Listening
1, 2, 4, 5, 6
Reading & Literacy
1, 2, 4, 7, 10
Writing
1, 2, 4, 5, 7, 10
Language & Vocabulary
3

Materials

- **Apollo 13 video footage**
- Items for sculpting such as plastic cups, plates, colored straws, pipe cleaners, toilet paper rolls, aluminum foil, paper clips, cardboard boxes (various sizes), plastic utensils (spoons, forks, knives), bottle caps, popsicle sticks, duct tape, coat hangers, empty water bottles, etc.
- **Design Thinking Planning,** 1 per team. (page 58)

Preparation

1. Assemble a box of random items, shown above, for each team.
2. Each box should contain the same items.

Procedure

PART ONE: UNDERLYING PROBLEM REVIEW	
1	**Say:** *We are about to watch a movie clip reenactment of an actual challenge that occurred on the Apollo 13 Space Mission.*
2	**Say:** *Space missions are well planned, and attention is given to every detail to achieve success. Unfortunately, things do not always go as planned. Unexpected, critical situations arise that require quick thinking, decision making, and problem solving. The Apollo 13 Mission to the Moon in 1970 is an example. An onboard explosion caused fatal damage to the spacecraft: systems had to be fixed to reduce the rising CO2 levels inside the craft to make the trip home possible. Without repair, the crew would die. Solving this challenge is an amazing example of collaboration between the space crew and ground control. The famous quote, 'Failure is not an option,' is still remembered today. Let's watch this clip reproducing the problem from the movie Apollo 13.*
3	Play the movie clip. Apollo 13 video footage.
4	Discuss the skills needed to successfully resolve the problem. Some ideas: • Teamwork • Communication skills • Leadership • Creative thinking • Problem solving • Taking action

Procedure, continued

PART TWO	
1	**Say:** *Today, you will participate in a Design Thinking Challenge. This is a collaborative event where you will work together to solve a problem or create a new product in a set amount of time.*
2	**Say:** *Each team will:* • *write a critical situation scenario that might occur during space exploration. Write the scenario in the box provided. This is a little bit like a challenge: what is the problem, why is it a problem, and why is it important to the situation?* • *write an underlying problem and brainstorm a solution, which they will construct from the items in their box.*
3	Distribute the **Design Thinking Planning** form and review the directions for each part. • Examine the items in the box. • Write the scenario: A critical situation happening during Space Exploration. • Develop an underlying problem. • Write a solution. (Review the components of solution writing that are on the sheet.) • Construct the solution
4	Provide work time.

Standards Addressed
Speaking & Listening
1, 2, 4, 5, 6
Reading & Literacy
1, 2, 4, 7, 10
Writing
1, 2, 4, 5, 7, 10
Language & Vocabulary
3

Closure

- Each team will read the following:
  - Their Space Exploration Scenario, highlighting their critical situation.
  - The underlying problem their team developed.
  - Their solution.
- Each team will share and explain the design prototype that their team created.

Name _____

Design Thinking Planning

1. Write a scenario describing a critical situation that might occur during space exploration.

2. Develop an underlying problem.

3. Brainstorm a solution. Fill in the boxes.

WHO will create the solution?

WHAT is the solution?

HOW will the solution work?

Explain **WHY** it addresses the key verb phrase and supports the purpose.

4. Build a prototype of your solution.

FUTURE Problem Solving LESSON PLAN

Out of This World Solutions

T STEP 3

Objectives

- Students will identify the key components of solution writing, answering the questions: Is the solution relevant? Is the solution elaborate, including who, what, how, and why it addresses the key verb phrase and supports the purpose.
- Students will analyze and evaluate solutions to determine if they are written correctly.
- Students will revise relevant solution ideas if they need to be clearly written or elaborated.

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 4, 5, 7, 10
Writing
1, 2, 4, 5, 7, 10
Language & Vocabulary
1, 2, 3

Materials

- **Evaluating Out of This World Solutions – Analysis Form**, 1 per group; 3 pages (pages 61-63)
- **Answer Key** (page 64)
- Stiff paper that can be folded into a tent – card stock, construction paper, etc. (1 tent per group)
- Underlying problem tents (1 per group)
- **Write Your Own Solutions**,1 per group (page 65)

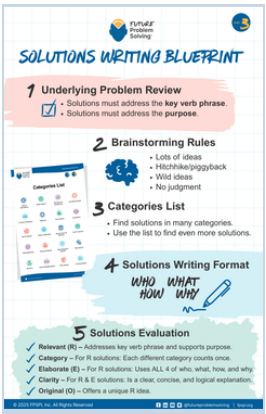
Preparation

1. Determine if students will work as partners or full teams. Prepare worksheets accordingly.
2. Prepare an underlying problem tent for each group. Fold a stiff piece of paper in half and write or glue the underlying problem below on both sides.

> Because the galaxy is becoming crowded with space debris, how might we reduce the risks of collision with space junk so that space exploration is safer in 2050 and beyond?

Procedure

1	**Say:** *The International Space Station (ISS), a large spacecraft orbiting Earth, has a permanent rotation population of astronauts and cosmonauts from different countries and holds a laboratory for science experiments.*
2	**Say:** *It has been requested that exemplary solutions to help solve the challenge of Space Debris, also called Space Junk, be submitted to the ISS. Space Junk is defined as any human-made object left in space that is no longer useful. The size of the junk can be as small as a paint fleck to as large as a school bus! Space Junk can come from a variety of sources such as satellites that have failed, any stage of a rocket, debris from explosions, and even items left behind by astronauts.*



Coaching Tip

Use additional Resource Library tools like the Solutions Writing Blueprint poster to provide additional inspiration for your students and reinforce the components of a well-written solution.

Out of This World Solutions

Procedure, continued

3	**Say:** *It will be your job to select the solutions to be sent to ISS for display and possible implementation. You will be evaluating three things for each solution:* • **Relevance:** The solution is counted relevant for the fluency score if it addresses the key verb phrase and supports the purpose of the underlying problem. • **Elaboration:** The solution is counted for elaboration points if it has all four of the who, what, how, and why. ◦ **WHO:** Tell who will create the solution. Avoid "cutesy" ideas like "Global Peace R' Us." Show thought and research by using viable organizations and companies. ◦ **WHAT:** Describe what the solution is. Optional: Create an interesting title for the solution. ◦ **HOW:** Describe how your solution will work. ◦ **WHY:** Refer back to the key verb phrase and purpose of the underlying problem to tell why the solution addresses the key verb phrase and supports the purpose. ◦ **Category:** The solution is assigned a category from the **Categories List** to determine the flexibility score.
4	Distribute the **Evaluating Out-of-This-World Solutions Analysis Form**. Place an underlying problem tent in the middle of each group. Review the Form and read the underlying problem out loud to the team.
5	Students will analyze each solution for excellence and make their recommendations for the International Space Station.
6	Solution review: The teams will share their analysis of the solutions.
7	The students will present the solutions selected for inclusion at the All-Star Solutions International Space Station Exhibit and explain their rationale. • Note: In Future Problem Solving there are no right answers. Student responses and selected categories may vary.
8	Students will vote for the top solutions for inclusion at the All-Star Solutions International Space Station exhibit.

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 4, 5, 7, 10
Writing
1, 2, 4, 5, 7, 10
Language & Vocabulary
1, 2, 3

Closure

1. Distribute **Write Your Own Solutions** and review the directions.
2. **Say:** *Follow the guidelines for writing solutions to create relevant, elaborate solutions for a new underlying problem.*
3. Monitor student work and discussions so you can provide evaluation feedback on their solutions.

Name _____

Out of This World Solutions – Analysis Form

Directions

1. Carefully read and analyze each solution:
   - **Relevance:** Check the box if the solution addresses the key verb phrase and supports the purpose of the underlying problem.
   - **Elaboration:** Check the box if the solution is elaborate with who, what, how, and why.
   - **Category:** Name the category this solution targets.
2. If the solution meets all criteria for the ISS, place a star in the box.
3. If the solution is relevant but does not contain all four components for elaboration, revise it in the space provided.
4. If the solution does not address the key verb phase or support the purpose of the underlying problem, mark it as not relevant.

Underlying problem

Because the galaxy is continually becoming crowded with space debris, how might we reduce the risks of collision with space junk so that space exploration is safer in 2050 and beyond?

ISS Solutions Analysis

1. The ISS will appoint a select team of physics experts to develop the "Space Junk Laser Zapper." The advanced laser beams will identify space junk and immediately disintegrate it. This will reduce the risk of collisions in the galaxy because collisions will be avoided. Space exploration will be safer as the Zapper minimizes the amount of space debris in the Galaxy.

☐ This solution is relevant.

☐ This solution is elaborate.

Category _____

If relevant but not elaborate: Rewrite to add details.

☐ This solution is nominated for the All-Star Solutions at the ISS.

☐ This solution is not relevant.

Page 1 of 3 ⟶

Name _____

Out of This World Solutions – Analysis Form

2. The Department of Education will identify space debris as part of the new science curriculum Astronaut Unit standards. Students will be educated about the dangers of collisions with space junk so they know what to expect if they travel into space.
☐ This solution is relevant.
☐ This solution is elaborate.
Category _____ If relevant but not elaborate: Rewrite to add details.
☐ Nominated for the All-Star Solutions at the ISS
☐ This solution is not relevant.

3. Space Nanobots will be created and released in the geocentric orbit to remove centuries-old space junk.
☐ This solution is relevant.
☐ This solution is elaborate.
Category _____ If relevant but not elaborate: Rewrite to add details.
☐ Nominated for the All-Star Solutions at the ISS
☐ This solution is not relevant.

Name _____

Out of This World Solutions – Analysis Form

4. The United Nations will enact an International Space Debris Treaty to regulate the disposal of space debris. This will reduce the risk of collisions in space because strict regulations will be established. Space exploration will be safer because countries will collaborate to keep the galaxy clean.

- ☐ This solution is relevant.
- ☐ This solution is elaborate.

Category _____

If relevant but not elaborate: Rewrite to add details.

- ☐ Nominated for the All-Star Solutions at the ISS
- ☐ This solution is not relevant.

5. Artists will establish the "Space Debris Art Exhibit." Local artists will contribute paintings of space junk and the dangers of its presence in the galaxy. This will raise awareness of the challenges faced by astronauts exploring space.

- ☐ This solution is relevant.
- ☐ This solution is elaborate.

Category _____

If relevant but not elaborate: Rewrite to add details.

- ☐ Nominated for the All-Star Solutions at the ISS
- ☐ This solution is not relevant.

FUTURE Problem Solving
ANSWER KEY

Out of This World Solutions – Analysis Form

STEP 3

1	The ISS will appoint a select team of physics experts to develop the "Space Junk Laser Zapper." The advanced laser beams will identify space junk and immediately disintegrate it. This will reduce the risk of collisions in the galaxy because collisions will be avoided. Space exploration will be safer as the Zapper minimizes the amount of space debris in the Galaxy. **Category:** Technology or Science This solution is **relevant** and **elaborate**. It may be nominated for the ISS All-Star Solution Exhibit.
2	The Department of Education will identify Space Debris as part of the new science curriculum Astronaut Unit standards. Students will be educated about the dangers of collisions with space junk, so they know what to expect if they travel into space. This solution is **not relevant** because it does not directly address reducing the risks of collisions.
3	Space Nanobots will be created and released in the geocentric orbit to remove centuries-old space junk. **Category:** Defense or Technology This solution is **relevant** but needs to be elaborated. Revise the solution to add who will initiate it and explain why it addresses the key verb phrase and supports the purpose.
4	The United Nations will enact an International Space Debris Treaty to regulate the disposal of space debris. This will reduce the risk of collisions in space because strict regulations will be established. Space exploration will be safer because countries will collaborate to keep the galaxy clean. **Category:** Government and Politics This solution is **relevant** and **elaborate**. It may be nominated for the ISS All-Star Solution Exhibit.
5	Artists will establish the "Space Debris Art Exhibit." Local artists will contribute paintings of space junk and the dangers of its presence in the galaxy. This will raise awareness of the challenges faced by astronauts exploring space. This solution is **not relevant**. It does not address the underlying problem. See #2.

Name _____

Write Your Own Solutions

Directions: Work with your group to write three relevant, elaborate solutions to the underlying problem below. Assign a category to each solution. Discuss your completed solutions with another group.

Underlying problem
Because astronauts face significant risks during long-term missions, how might we improve safety measures in order to maintain astronauts' well-being during space exploration in 2050?

1.

Category _____

2.

Category _____

3.

Category _____

FUTURE Problem Solving LESSON PLAN

A Journey Through the Galaxy of Evaluation

T STEP 4 STEP 5

Objectives

- Students will demonstrate an understanding of criteria by:
  - Recognizing correctly formatted criteria.
  - Writing correctly formatted criteria.
  - Analyzing underlying problems in order to develop high quality criteria.
- Students will apply criteria to the evaluation grid.

Standards Addressed
Speaking & Listening
1, 2, 3, 4, 6
Reading & Literacy
1, 2, 4, 5, 10
Writing
2, 4, 5, 7, 10
Language & Vocabulary
1, 2, 3

Materials

- **Flyby Mission #1 – Structura**, 1 per student (page 68)
- **Flyby Mission #2 – Exoplanet Applicata**,1 per student (page 69)
- **Flyby Missions #1 and #2 Guided Practice,** for coach reference. (page 70)
- **Flyby Missions #1 and #2 – Now It's Your Turn**,1 per team (page 71)
- **Flyby Mission #3 – The Gridiron Galaxy,**1 per student. (page 72)
- **Flyby Missions #1, #2, and #3 Answer Key** for coach reference. (page 73)

Preparation

1. Determine how to share the underlying problem from the Guided Practice and how to record student suggestions for criteria.

Procedure

INTRODUCTION TO THE LESSON	
1	**Say:** *The next step of the Future Problem Solving process is to generate and select criteria. Criteria serve as yardsticks to measure the creative potential and importance of solution ideas. They help us to analyze how solutions compare against each other. Criteria are the standards by which solution ideas are judged.*
2	**Say:** *The solution idea that best meets all criteria is considered the 'best solution' and becomes the basis for the action plan.*
3	**Say:** *In this lesson, we will take a few flyby space missions to discover the steps of writing criteria and completing the Future Problem Solving evaluation grid.*

FLYBY MISSION #1 STRUCTURA	
1	**Say:** *Our first flyby is to the planet Structura, where we will gain information on how to develop correctly written criteria. Let's use our imagination to experience the flyby. Sit back and close your eyes. Take a deep breath … slowly let it out. Now imagine you are drifting in the quiet of space. The stars shimmer in the distance, and your spacecraft glides through the vast expanse of the cosmos. Your destination, Structura, is ahead of you, an orbital outpost known for its precision and order. Here, you will gather knowledge to build strong, structured criteria that will lead your team to success. Take one final deep breath and return ready to review the data you collected through the flyby.*
2	Distribute **Flyby Mission #1 Structura**. Review the material and answer questions. Note: There is no activity on this sheet; it introduces the structure of criteria.

Procedure, continued

	FLYBY MISSION #2 EXOPLANET APPLICATA
1	**Say:** *Now that you understand the structure of correctly written criteria, it is time to board the spaceship for our second flyby mission to the exoplanet Applicata. Sit back and close your eyes. This is an opportunity to relax. Take another deep breath in and slowly breathe out. Now, imagine yourself floating through the quiet of deep space, your spacecraft gliding effortlessly toward the exoplanet Applicata. Applicata is a world that is purposeful, relevant, and focused. As you flyby, you will gain knowledge on how to develop high quality criteria that address the underlying problem. The residents of Applicata will provide you with data and an important message for writing criteria: 'Only the relevant survive.' Take one final deep breath and return ready to review the data you collected through your flyby of Applicata.*
2	Distribute **Flyby Mission #2 Exoplanet Applicata**. Review the material and answer questions.
3	**Say:** *Let's practice writing criteria with a different underlying problem.*
4	Present the underlying problem from **Flyby Missions #1 and #2 Guided Practice.** Lead students to develop both generic and targeted criteria related to the underlying problem. They do not need to write these down, it is just for brainstorming.
5	Distribute **Flyby Mission #1 and #2: Now It's Your Turn**. Review the directions.
6	Provide work time, then allow students to share and discuss their criteria.

	FLYBY MISSION #3 GRIDIRON GALAXY
1	**Say:** "It is time for our last flyby in this step of the Future Problem Solving process. Are you ready? Close your eyes, relax your shoulders, take a deep breath in… and slowly let it out. Imagine you are floating peacefully through the vast reaches of space, heading toward your next destination—the brilliant **Gridiron Galaxy**. Gridiron Galaxy is a place where decisions are made carefully and systematically. As you flyby, you will gain information and learn that the best decisions are made through careful thought, fair evaluation, and honest reflection. Pause momentarily as you float through this galaxy and, as your spaceship lands, prepare to explore the evaluation grid.
2	Distribute **Flyby Mission #3 Gridiron Galaxy.** Review the material and answer questions.
3	Provide work time.
4	Review answers (see **Answer Key**)
5	**Say:** *You will have an opportunity to try out the grid in the next lesson, which is a practice situation.*

Standards Addressed
Speaking & Listening
1, 2, 3, 4, 6
Reading & Literacy
1, 2, 4, 5, 10
Writing
2, 4, 5, 7, 10
Language & Vocabulary
1, 2, 3

Name _____

Flyby Mission #1 – Structura

Structura is a precision-engineered space station orbiting near Saturn's rings. Here, nothing functions without clear organization and well-built systems. Astronauts on Structura believe,

"Without structure, even the brightest stars can collapse."

This is also true when writing criteria. As you flyby, you will gain knowledge on how to structure correctly written criteria.

Data collection

1. Vocabulary:
   - "Criterion" is the singular form (a criterion);
   - "Criteria" is the plural form.
2. A correctly written criterion is a matter of structure. Each criterion:
   - Focuses on a single standard
   - Demonstrates a measure of degree using a superlative
   - Indicates the desired outcome
   - Is recognizable as a question
3. The evaluator awards 2 points for each criterion that meets the requirements shown above.

CRITERIA WRITING CHART

Each criterion focuses on a single standard. It measures only one dimension – for example, cost or time, not cost and time in the same criterion. Do not use the words "so that" or you will have two dimensions.
Each criterion demonstrates a measure of degree using one superlative – a word of measurement such as best, most, highest, etc.
Each criterion indicates a desired, positive outcome. For example, which solution **best** improves not **least** improves.
Each criterion is written as a question. Begin with "Which solution…." and put a question mark at the end.

Example: Which solution will have the most positive environmental impact?

Name _____

Flyby Mission #2 – Exoplanet Applicata

Exoplanet Applicata is a world that is purposeful, relevant, and focused. As you flyby, you will gain knowledge on how to develop high quality criteria that address the underlying problem. The slogan on Applicata is

"Only the relevant survive."

Data collection

1. Applicability measures the usefulness of a criterion as it applies to the underlying problem.
2. The charts below explain two types of criteria.
3. The evaluator awards 3 points for each generic criterion and 6 points for each targeted criterion.
4. Criteria that are not applicable or are duplicates of other criteria do not receive points.

CRITERIA APPLICABILITY CHART

Generic criteria

A generic criterion can be applied to nearly any underlying problem from any future scene.

- Example: Which solution will be easiest to implement?

A criterion is still generic if you simply add future scene parameters (time, place, topic) or stakeholders, without a clear, applicable connection to the underlying problem.

Examples:

- Which solution will be easiest to implement in 2050 and beyond?
- Which solution will be easiest for the members of the space exploration team to implement?

Targeted criteria

Targeted criteria apply specifically to the underlying problem and would be significant in judging solutions to find the best solution.

A target criterion can be:

- Based on the key verb phrase of the underlying problem.
- Based on the purpose of the underlying problem.
- Specific to the underlying problem.
- Justified with relevant future scene facts that relate to the underlying problem.

Examples using this underlying problem

Because astronauts face significant risks during long-term missions, how might we improve safety measures in order to maintain astronauts' well-being during space exploration in 2050?

- Which solution will best improve safety measures during long-term missions? (KVP)
- Which solution will best maintain astronauts' well-being during space exploration? (purpose)
- Which solution will most reduce the risks of accidents during long-term missions? (specific)

FUTURE Problem Solving
ANSWER KEY

Flyby Missions #1 and #2 Guided Practice

STEP 4 STEP 5

Directions

1. Display or share the underlying problem.
2. Lead students to develop applicable, correctly written criteria related to the underlying problem.
3. A criterion should begin "Which solution…."
4. Compare the students' criteria to the possible ones shown below.

Underlying problem

Because the galaxy is continually becoming crowded with space debris, how might we reduce the risks of collision with space junk so that space exploration is safer in 2050 and beyond?

Possible generic criteria

- Which solution will be the most cost-effective?
- Which solution will be safest to implement? (This one does not come from the purpose.)
- Which solution will be quickest to implement to reduce the risks of collisions with space junk? (Just adding words of the underlying problem does not necessarily make a criterion targeted.)
- Which solution will be the easiest to implement in space?

Possible targeted criteria

- Which solution will most reduce the risks of collision with space junk? (KVP)
- Which solution will make space exploration the safest? (purpose)
- Which solution will remove the greatest amount of space junk? (specific)
- Which solution will best clear the lines of travel for space exploration of space debris? (specific)
- Which solution to clear space junk will apply to the most different kinds of space debris? (specific)

Examples of criteria that are <u>not</u> correctly written

- Is it quick to implement? (no superlative)
- Ease of implementation (not a question; no superlative)
- Which will be inexpensive? (no superlative)
- Which is time-efficient? (no superlative)
- Will it be easy and cheap? (two dimensions; no superlative)
- Which will be approved by space exploration organizations? (no superlative)

Examples of criteria that are <u>not</u> applicable

- Which is most efficient? (Evaluators want to know "efficient for what?")
- Which will solve our underlying problem the best? (Too generic, more criteria needed to determine this!)
- Which will be most effective? (Effective for what?)
- Is it creative?
- Which will use the most technology? (Wrong direction)

Name _____

Flyby Mission #1 and #2 – Now It's Your Turn

STEP 4 STEP 5

Directions: You learned a lot about correctly written and applicable criteria by collecting research on your Flyby Missions #1 and #2. Now, it is your turn to put what you learned into practice. Use the following excerpt from a future scene and the underlying problem provided. Refer to the **Criteria Writing Chart** and **Criteria Applicability Chart** as needed to develop criteria related to the given underlying problem.

Future scene excerpt
NASA's upcoming Gaia Guardian Mission is set to launch in 2045, aimed at studying distant exoplanets for signs of life. However, despite its ambitious goals, the mission has raised concerns over its environmental impact. The massive rocket required for the journey will release an estimated 500 tons of carbon dioxide during launch, contributing to atmospheric pollution. The increased demand for space exploration has also led to more debris in Earth's orbit, further harming the environment. Critics argue that missions like Gaia Guardian must prioritize sustainability to avoid long-term damage to both Earth and space ecosystems.

Underlying problem
Because space travel contributes to significant environmental damage through rocket emissions and debris accumulation in 2045, how might we improve environmentally sustainable practices for space exploration so that the negative ecological impact on the Earth's atmosphere in outer space is minimized?

Generic criterion
Which solution will cost the least for NASA's space exploration program?

Targeted criterion
Which solution will best improve environmentally sustainable practices for NASA's space exploration missions in 2045?

Write three targeted criteria

1.

2.

3.

Name _____

Flyby Mission #3 – Gridiron Galaxy

The Gridiron Galaxy is a place where solutions compete to shine the brightest. Explorers use a complex evaluation grid to compare stars and planets, choosing the ones that will sustain future missions. As you fly-by, you will gain knowledge on how to use the evaluation grid to systematically score solutions based on the established criteria and identify the one that offers the best outcome. The slogan is

"The right solution will always outshine the rest."

Data collection

1. First, select your most promising solutions to the underlying problem and list them briefly in the first column of the grid. For a practice booklet, this may be 4 or 5 solutions; in competition, it is 8 for a team.
2. The solutions are then compared against each criterion, one at a time, and given a rank to show how well the solution meets the criterion. If you use 5 solutions in the grid, rank them from 5 to 1 where 5 means the solution fits that criterion best and 1 means it does not meet that criterion.
3. Repeat this until you have ranked all the solutions against each criterion.
4. Add the rows across.
5. The solution with the highest row total is the best solution.
6. The grid has been used correctly when:
   - Each ranking number (5 to 1 or 8 to 1) appears once in each column, with no numbers repeated.
   - The rows have been added correctly: check your addition with a calculator!
   - The grid has not been manipulated. This means that the team has used the grid correctly, without deciding ahead of time which solution will win.
   - The highest scoring solution is used in Step 6 for the action plan.
7. The grid below has two mistakes. Can you find them?

Solutions	Criterion #1	Criterion #2	Criterion #3	Criterion #4	Criterion #5	Total
Reuseable Green Propulsion Rockets	1	5	4	5	3	18
Orbital Clean-Up Drones	5	3	3	4	4	20
Debris to Energy Converters	2	2	2	1	1	8
Biodegradable Space Craft Materials	4	4	5	3	5	21
Space Elevator Technology	3	1	2	2	2	10

Evaluation points awarded

- 20 points: The grid is complete, has appropriate ranking numbers in each column, rows are added correctly, and the highest-scoring solution has been used in Step 6.
- 14 points: Grid contains errors of incorrect addition, repeated numbers in columns, ranking is in wrong direction (rank of 1 is best instead of worst)
- 7 points: Inaccurate application of the grid – the same number appears all the way across a row for every row, the highest scoring solution is not used in Step 6.

FUTURE Problem Solving
ANSWER KEY

The Future Problem Solving Process in Action

STEP 4 STEP 5

Flyby Mission #1

Underlying Problem
Because space travel contributes to significant environmental damage through rocket emissions and debris accumulation in 2045, how might we improve environmentally sustainable practices for space exploration so that the negative ecological impact on the Earth's atmosphere in outer space is minimized?

Notes

- Students may think of other valid criteria.
- Point out when a criterion is so close in content to another one that an evaluator could call it a duplicate.

Flyby Mission #2

Sample targeted criteria

- Which solution will most improve environmentally sustainable practices for space exploration? (key verb phrase)
- Which solution will best minimize the negative ecological impact on the Earth’s atmosphere in outer space? (purpose)
- Which solution will best reduce the accumulation of space debris? (specific)
- Which solution will most reduce pollution during launch? (specific)
- Because critics argue that missions like Gaia Guardian must prioritize sustainability to avoid long-term damage to both Earth and space ecosystems, which solution will be most likely to satisfy the critics? (justified with future scene fact)
- Because the upcoming Gaia Guardian Mission is set to launch in 2045, which solution will be least disruptive to NASA’s schedule for the Gaia Guardian Mission? (justified with future scene fact)

Sample generic criteria for this underlying problem

- Which solution will be the most sustainable over time?
- Which solution will NASA be most likely to implement?
- Which solution will cost the least for NASA to implement?
- Which solution will use the least resources?
- Which solution will be the best for Earth’s atmosphere?

Flyby Mission #3

Mistakes

- **Row error:** the row with the solution “orbital clean up drones” is not added correctly. The total should be 19, not 20.
- **Column error:** Criterion #3 column has two 2s and no 1.

The Future Problem Solving Process in Action

LESSON PLAN

STEP 1 STEP 2 STEP 3 STEP 4 STEP 5 STEP 6

Standards Addressed
Speaking & Listening
1, 2, 4, 6
Reading & Literacy
1, 2, 3, 4, 5, 6, 7, 8, 10
Writing
1, 2, 4, 5, 6, 7, 8, 9, 10
Language & Vocabulary
1, 2, 3

The lessons in the rest of this unit provide opportunities for students to practice the Future Problem Solving process before tackling the official future scene.

A Fun Future Scene (pages 75-82)

- This is a shortened version of the Future Problem Solving process developed to focus on the writing format of each step.
- Assemble the booklet or insert them into Google Docs. (1 per team)
- Designate an assigned time for the students to complete the booklet.
- Review the team's work and provide feedback for improvement.

A Practice Future Scene (pages 83-84)

- This lesson should simulate the competition guidelines.
- Find a meeting space where students will be secluded and not interrupted.
- Use the official competition booklet.
- Be strict with the timing.
- Review the team's work and provide feedback for improvement.

Back to the Launch Reflection – Did We Reach Our Goals for Success? (page 85)

- Each student will complete the reflection sheet individually.
- Discuss and compare their reflection responses.
- Answer any questions or concerns listed.

An additional idea

- Use the following movies as a visual Space Exploration future scene.
- Review them to determine if they are appropriate for your class.
- Identify a stopping point where the students can identify challenges using the **Categories List,** write an underlying problem, produce solutions, evaluate their ideas, and develop an action plan.

The Martian (PG13)	The Preview
Apollo 13 (PG13)	The Preview
The Right Stuff (PG)	The Preview

*A Long List of Other Space Exploration Movies

A Fun Future Scene

Space Exploration – **The Right Stuff, Practice Makes Perfect** *(Topic Activity Unit)*

May 3, 2060

Dear Diary,

I'm sorry my handwriting is so bad. It's been forever since I've even tried to write with a pen. But since OrionNet is down, I haven't had any other choice. For the last week, my life as I knew it has totally stopped. And I think I'm starting to go nuts.

I was in math class at Galileo Virtual Academy when it happened. OrionNet, the fastest, most powerful satellite ever created, is so efficient that five years ago, Canada started an online school for the top students across the country. We were talking about factoring binomials when suddenly, my StarPad screen went blank. I tried turning it on and off because sometimes that works, but it wouldn't even turn back on. Not only that, but all the lights were out in the whole house!

My dad is a space traffic controller, managing the hundreds of satellites orbiting the Earth, so he immediately told me what happened. A satellite that hasn't been used in decades and is just floating around out there slammed into a new one that just reached orbit, creating a huge chain reaction with other space junk and existing satellites. One of them was OrionNet. Without it, nothing works, and society doesn't work either. Nobody can buy anything or watch VirtualTube, and I have no idea what's going on at school.

But then it got worse. Just a day later, a massive piece of space debris from the collision crashed in a town a few hours away from where we live in Edmonton, destroying a whole block of homes. Thankfully, nobody was hurt, but the government is fearful of more space junk falling out of the sky. They've ordered all the surrounding towns to evacuate. Luckily, we weren't affected, but there have been five other incidents of falling space debris. Everyone is really scared they'll be hit next!

Fortunately, there's an emergency satellite Dad uses for work that hasn't been affected, and he and the other space traffic controllers are working around the clock trying to find a solution. He says that the collision created a massive debris cloud that is too large to clean up using normal methods, and they'll have to figure out something else. I heard him tell my mom that no one at work knows when things will be back to normal!

Parameters

Time:

Place:

Topic:

WARNING:
This is not an official future scene. DO NOT USE this future scene for your Practice Problem 2 Space Exploration submission.

Page 1 of 2 ⟶

A Fun Future Scene

Meanwhile, we can't go outside at all. The whole province of Alberta has to stay indoors. The worst part is that I can't practice HoverFrisbee with my friends, and the rest of our season will probably get canceled! We were having our best season ever, and I was really looking forward to going to the International Frisbee Throw. My mom is also driving me nuts. Risking the space debris, she's been raiding every EcoMart in the area and has almost gotten trampled to death buying food to hoard!

My dad's work has some ideas for solutions, but so far, all of the ideas will take months to implement. I'm so stressed out. I miss school and my friends. Maybe new problem-solvers will identify action plans to solve the crisis with the space junk!

Your friend,
Andy

WARNING:
This is not an official future scene. DO NOT USE this future scene for your Practice Problem 2 Space Exploration submission.

Name _____

Step 1 - Identify Challenges

Directions

1. Carefully analyze the future scene and identify the charge.
2. Generate possible challenges.
3. Write four challenges following the Future Problem Solving guidelines.
4. Incorporate research and vocabulary.
5. Use the **Categories List** to help increase flexibility.

1.

2.

3.

4.

Name _____

Step 2 - Write an Underlying Problem

Directions

1. The underlying problem provides the direction for the rest of your packet.
2. Carefully read the colorful paragraph. It is called the “charge” and provides direction for the focus of your underlying problem.
3. Determine an underlying problem that addresses the charge.
4. Write the underlying problem following the Future Problem Solving guidelines.

Name _____

Step 3 - Produce Solution Ideas

Directions

1. Carefully analyze the underlying problem and generate solution ideas.
2. Write four elaborate solutions following the Future Problem Solving guidelines.
3. Incorporate research and vocabulary.
4. Use the **Categories List** to help increase flexibility.

1.

2.

3.

4.

Name _____

Step 4 and Step 5: Select and Apply Criteria

Directions

1. Generate five criteria to use when determining which solution idea best solves the underlying problem and/or addresses the future scene situation.
   - Written as a question: “Which solution will…”
   - Has a superlative
   - Addresses only one dimension
   - Written in a positive direction

Select criteria

1
2
3
4
5

Apply criteria

Write the four solution ideas from Step 3 briefly in the first column. Use each criterion to rank the solutions on a scale from 1 (poorest) to 4 (best).

Solutions	Criterion #1	Criterion #2	Criterion #3	Criterion #4	Criterion #5	Total

Our best solution

Name _____

Launching Your Action Plan

Step 6. Learn to write an action plan

Directions: Before continuing to create your action plan, review the following important components an action plan should include.

Remember

- The action plan is based on the best solution identified in Step 4.
- Describe the initial solution idea from Step 3 and present a detailed proposal for solving your underlying problem and making an impact on the future scene.

STAGE ONE

Discussion of criteria – measures the degree to which the criteria are addressed in selecting the best solution (2 - 10 points)

Before you provide the details of your action plan, you need to explain how this solution became your best one out of the other chosen solutions.

The following are some points you might address:

- Explain why this solution scored higher than several other top-scoring solutions on the criteria.
- Why is this solution better on most of the criteria and not as good on the others?
- What put this solution “over the top” in comparison to the other high-scoring solutions?

STAGE TWO

Completeness and clarity – considers the extent of elaboration of the plan.
(Completeness: 2 - 20 points, Clarity: 2 - 10 points)

The following are some points to discuss:

- Explain your best solution in detail. Elaborate on your original solution idea with who, what, where, when, and how.
- Consider obstacles and sources of resistance to implementing your action plan. How might you overcome these challenges?
- Describe how sources of assistance may be used to help your plan be successful.
- Include a timeline.

STAGE THREE

The relationship to the underlying problem – measures how well the action plan solves the underlying problem
(Relationship**:** 2 - 10 points, Impact: 2 - 20 points)

The following are points to discuss:

- Explain how the plan addresses the key verb phrase of the underlying problem.
- Explain how the plan supports the purpose.

Name _____

Launching Your Action Plan

STAGE FOUR

The impact on the future scene – measures the positive effect of the plan on the future scene.

- Discuss how the plan will have a positive impact on the future scene.
- Highlight the impact of the plan on the future scene charge.
- Bring in points related to how the plan affects the topic concerns in the future scene.

THROUGHOUT THE ACTION PLAN

Humaneness – measures the positive/productive outcomes of implementing the best solution.
(2 - 10 points)

The description of your action plan should accentuate the positive aspects of your plan, showing concern for living things and the environment in the future scene.

Fundamental concepts – provides scores for the overall action plan.
(Research Applied: 1 - 5 points, Creative Strength: 1 - 5 points, and Futuristic Thinking: 1 - 5 points)

In your plan, show off your topic research, strive to include creative details, and project the ideas, trends, and technologies in your plan into the time of the future scene.

Practice Future Scene

Space Exploration *(Topic Activity Unit)*

Dr. Sandra Howard, director of the Galactic Initiative, sank back into her chair, setting the latest environment report on her desk. The situation was grim. The earth's environment had gradually deteriorated since the 2020s, but now, in 2052, it seemed worse than ever. Rapid population growth and increased industrial activities have led to the depletion of fossil fuels, rare minerals, and even clean water, leading to an unprecedented energy crisis. Fuel prices have skyrocketed, creating economic hardships. An attempt at deep-sea drilling led to the worst oil spill in 50 years.

She picked up a second report: the newest update from the Galactic Initiative. Formed five years ago, the team consisted of a coalition of governments and private companies to expand space exploration efforts. At first, the explorations used autonomous spacecraft, but after initial expeditions revealed significant water reserves and minerals on Europa, one of Jupiter's moons, their efforts shifted to setting up a permanent base with a staffed crew to extract the resources.

The potential this mining operation offers is extensive: a surplus of platinum, gold, and rare earth elements critical for electronics and renewable energy technology. This promises to reduce the strain on Earth's dwindling resources, but it would also lead to new technological innovations, boost the economy, and offer new solutions to combat climate change.

The first manned expedition to Europa is scheduled for next month. Yet, despite the many benefits of the mining project, the Galactic Initiative is facing opposition on multiple fronts. The multinational corporation AstroCore Industries has threatened to legally challenge the program based on the Outer Space Treaty, claiming that it has no right to claim property on Europa. However, rumors out of AstroCore also indicate that they may also be developing a manned expedition to Europa.

Parameters

Time:

Place:

Topic:

WARNING:
This is not an official future scene. DO NOT USE this future scene for your Practice Problem 2 Space Exploration submission.

Page 1 of 2 ⟶

Practice Future Scene

Space Exploration (*Topic Activity Unit)*

Opposition comes from the public level, too. Environmentalists in Sacramento, California, the Galactic Initiative's headquarters, are protesting the expeditions due to the significant carbon emissions in space exploration, arguing that people must focus on resolving Earth's climate issues. The activist group Guardians of the Sacred Sky, comprised of Indigenous leaders, environmentalists, and cultural advocates, has voiced that people are morally obligated to protect the sanctity of other celestial bodies and their potential life forms.

These pressures aren't lost on the astronauts preparing to relocate to Europa. The team of five astronauts will work independently on Europa to extract minerals and water to send back to Earth in unmanned space craft. They are preparing to live the rest of their lives in space. While they may have fears, they ultimately believe they are doing a service to the people of Earth.

Dr. Howard lay her head in her hands. There is so much at stake with the Galactic Initiative and the need to balance environmental concerns with the grave need for resources on Earth. Identify the most important issue for the Galactic Initiative and formulate an action plan.

WARNING:
This is not an official future scene. DO NOT USE this future scene for your Practice Problem 2 Space Exploration submission.

Name _____

Launch Reflection

Directions

1. Review the goals you set at the start of this unit for improving the Future Problem Solving process related to the evaluator feedback.
2. Analyze your team's progress in further mastering the steps of the Future Problem Solving process.
3. Identify where you achieved the most success.
4. Refine your plan before beginning the Space Exploration booklet by listing important goals for your team's performance below.

Check the following areas where you felt very accomplished.

- ☐ Teamwork
- ☐ Research
- ☐ Identifying and writing challenges
- ☐ Selecting and writing an underlying problem
- ☐ Developing imaginative, futuristic solutions
- ☐ Developing and writing relevant criteria
- ☐ Correctly using the evaluation grid
- ☐ Writing an action plan
- ☐ Completing the competition within the set time limit.

Write a note to your coach with any questions or concerns you still have before the booklet.

FUTURE Problem Solving

Additional curricular resources

We hope you find this edition of our activity unit series to be a valuable resource as your students gather knowledge about Future Problem Solving topics of study.

Space Exploration Research Unit

Our research unit on this topic contains a wealth of curricular resources for use with students in a variety of settings, including out-of-school time. The topic research overview identifies major themes and concepts while the resources section includes vocabulary, discussion topics, learning prompts, and assessments. Also, our curated list of suggested readings and digital resources for the topic contains helpful summaries.

Global Issues Champions Series

This series showcases student written work for the 2024 Global Issues world champion team and individual competitors by division. Their full evaluations are included. To use this publication as a coaching tool, first review the Air Quality future scene with your students. Then ask students to complete a booklet using the future scene. You can do this as a mock competition or step by step as practice. For students looking to deepen their understanding of evaluations, we recommend that you give each team a copy of the student work, step by step. Ask students to identify strengths and weaknesses in the sample work based on their understanding of the scoring rubric. Review the evaluation concepts identified in each step and look at the scores and feedback from evaluators together.

Education Standards

Our Future Problem Solving process fulfills a wide variety of education standards. We take connecting with these standards into account when developing our program materials. Teachers can easily tailor Future Problem Solving content to meet their specific education system and local requirements as needed.

How our topics are selected

Our topics represent important challenges from business, civics, society, science, and technology and serve as the thematic basis for given problem solving situations. Each school year, students get 3-5 opportunities to solve important near-future global issues based on their progress in local and regional competitions. To be considered, a topic must be broad enough to appeal to participants living around the globe, offer a range of themes and issues to explore, and be considerate of a variety of views. Lastly, of course, every topic must be accessible for all, from ages 8 to adult.

We welcome submissions of topic ideas from anyone year round. Our topics committee reviews, refines, and categorizes submissions into our diverse strands. Then options are narrowed down and screened by our regional affiliate leaders. They pre-select top candidates for each of the category strands to present to our entire global community for a vote. The community's input, including students, heavily influences the final selection. We announce topics for the upcoming competition season March 1.

About Future Problem Solving

Future Problem Solving proudly celebrates over 50 years of placing more than a million young people at the core of a dynamic, purposeful learning experience. Each year K-12 students around the world participate in a variety of challenges designed to empower curious youth to become changemakers. Problem solvers learn how to think, not what to think, and gain skills they need to succeed in work and life. Our programs help young people develop their own voices and the confidence to use them.

To learn more about Future Problem Solving, to submit a topic idea, or contact us, visit fpspi.org.