How can we improve our Model Rocket Checklist?

Grade Band: Middle School • Discipline: ETS • Time: Two 50-minute class periods

Lesson Level Performance Expectation
- Analyze patterns in class data to modify a model rocket checklist and parachute to meet the descent time criteria.
- Consider parts of other groups’ checklists or parachute modifications using patterns in class data to determine what could be incorporated to create a better checklist and parachute.

What Students Will Figure Out
- After testing a potential solution, we can use patterns in class data to improve our Model Rocket Checklist and parachute design.
- Combining parts of different solutions is a good strategy for improving a design solution (Model Rocket Checklist and parachute design).

Lesson Snapshot
Middle school students, as scientists, use science ideas about forces and motion, particle motion, and chemical reactions to answer the following driving question: How can we improve our Model Rocket Checklist? Students begin by analyzing group and class launch data. Groups then discuss their checklist and rocket launch with another group. Based on their discussion and data, students revise their checklists to improve clarity and safety and to meet the design criteria. Students present their revised checklist to an audience.
How can we improve our Model Rocket Checklist?

Middle School • Discipline: ETS

Problem:
Will vary depending on problems identified by each group in the previous launch. Or if there were no safety issues, students can work on optimizing the flight.

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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</thead>
<tbody>
<tr>
<td>Analyze and Interpret Data</td>
<td>ETS1.B: Developing Possible Solutions</td>
<td>Patterns</td>
</tr>
<tr>
<td>• Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.</td>
<td>• A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)</td>
<td>• Graphs, charts, and images can be used to identify patterns in data.</td>
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<tr>
<td>Obtaining, Evaluating, and Communicating Information</td>
<td>• Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)</td>
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<td>• Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations*</td>
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This lesson could be one in a series of lessons building toward the following Performance Expectation(s):
MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Materials

<table>
<thead>
<tr>
<th>Student Materials</th>
<th>Teacher Materials</th>
<th>Optional Teacher Resources</th>
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<tbody>
<tr>
<td><strong>Per Student</strong></td>
<td>• Phone or other device that recorded model rocket launches during Lesson 6</td>
<td>• NSTA Science Scope: &quot;Assessing Student Presentations from Three Perspectives*</td>
</tr>
<tr>
<td>• National Association of Rocketry (NAR), Safety Code</td>
<td></td>
<td>• Edutopia: &quot;The Secret to Great Middle School Presentations*</td>
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<tr>
<td>• Model Rocket Checklist and Data Collection</td>
<td></td>
<td>• Edutopia: &quot;How a Simple Presentation Framework Helps Students Learn*</td>
</tr>
<tr>
<td>• Student Unit Model Tracker</td>
<td></td>
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<tr>
<td><strong>Per Small Group (2 to 4 students)</strong></td>
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<td></td>
</tr>
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<td>• Phone or other device that recorded model rocket launches during Lesson 6</td>
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</table>
Lesson Preparation

Previous Knowledge Used (This lesson and the lessons that follow assume students already were taught a unit addressing the following DCIs.)

ESS2.D: Weather and Climate

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)
- Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)

If students are not already familiar with these weather and climate concepts, we recommend the following NSTA resources.

- Weather Collection of Resources
- Weather and Climate Collection of Resources

Presentation of Checklists

Determine the choices that will be offered to students in terms of audience and format for the checklist. See the suggestions below, and be sure to check your school or district policies before posting student content online. Also consider reviewing some of the optional resources for teachers for tips on setting up successful middle school presentations.

**Audience**

- Students at their school
- Students at a different school
- Community members
- General public

**Format**

- Presentation
- Video
- Social media post
- Infographic
Experience the Problem

What Students Are Doing

In this section, students analyze and look for patterns in group and class launch data. Students use their understanding of forces and motion to explain what they observed.

Teacher Guidance

1. Ask groups to watch the video of their launch.

Suggest that students watch the video at full speed and in slow motion. Ask students to record what they notice and wonder, as well as ideas they have about improving their parachute or checklist, on page 9 of the Model Rocket Checklist and Data Collection document.

Suggested Prompts

• Did the rocket launch? Can you draw a model to describe what you think happened? What would the force arrows look like? If not, how could you rewrite your checklist, rebuild your rocket, or redesign the parachute to increase the chance of success in a future launch?

• Did the nose cone and parachute eject? Can you draw a model to describe what you think happened? What would the force arrows look like? If not, how could you rewrite your checklist, rebuild your rocket, or redesign the parachute to increase the chance of success in a future launch?

• Did the rocket land safely 20–26 seconds after the parachute ejected? Can you draw a model to describe what you think happened? What would the force arrows look like? If not, how could you rewrite your checklist, rebuild your rocket, or redesign the parachute to increase the chance of success in a future launch?

If students are having difficulty connecting their observations of the launch to the science ideas they figured out in the unit, consider using the following prompts.

Sample Student Responses

Student responses will vary depending on their launch experience, but below are a few sample responses.

• Our nose cone did not eject. There must have been too much friction. We would draw an arrow pointing down on the nose cone that is bigger than the one pointing up. We think the nose cone was put on too tightly or the parachute was packed too tightly inside the body tube. Both of those things could have increased the size of the friction force.

• The rocket did land in a safe location 20–26 seconds after the parachute ejected. We think the size of our spill hole helped it land at a “just right” speed. The hole in the parachute kept air from getting trapped under the parachute, so the force exerted by the air particles on the parachute was not as large as a parachute without a hole.
2. **Ask groups to share their data with the class.**

As a group presents their data, the rest of the class should record data in the data tables on page 10 of the [Model Rocket Checklist and Data Collection](#) document. Consider also recording the data on a board located where all students can see the data.

Once all groups have shared their data, direct students to graph the data using the graph on page 11. Ask groups to discuss what patterns they notice in the data and answer questions 1–3 of the Analyze Data section on page 12. Give groups time to discuss their ideas, then lead a whole-class discussion.

### Suggested Prompts
- What did you notice about the data?
- What patterns did you observe in the data presented in the graph?
- Based on the data, do you think there is a relationship between the size of a parachute spill hole and descent time?
- As the size of the spill hole increased, what happened to the descent time?
- How can we use what we know about forces and motion to explain the pattern in the data?
- Did any of the data not fit the pattern? Why do we think this happened?

### Sample Student Responses
- The bigger the spill hole, the faster the rocket landed.
- There is a relationship between the size of the spill hole and the descent time. The bigger the hole in the parachute, the smaller the number of air particles that gets trapped under the parachute. A smaller number of air particles will exert a smaller force up on the parachute, so it will land faster.
- Our parachute had a small hole, but the parachute did not open, so the rocket came down fast.
Develop a Solution (Day 1 and 2)

What Students Are Doing
In this section, students consider aspects of other groups’ designs that they could incorporate into their checklist or parachute design. Students then revise their checklist and prepare to present it to an audience.

Teacher Guidance

3. Arrange the class to allow each group to discuss their data and receive feedback from another group.
Tell groups to discuss their observations, video, checklist, and class data. Groups should consider if there are parts from the other group’s parachute design or checklist that can be combined with their ideas to improve their checklist and ensure that a future launch would meet the criteria.

Suggested Prompts for Students
- What steps did your group include in your checklist?
- Do you think you followed all of the steps in the checklist while constructing and launching your rocket?
- What did you observe during the rocket test? Did the recovery system deploy?
- Did the rocket land between 20–26 seconds after the ejection of the parachute?
- How will you use the pattern we observed in the class data to improve your checklist and parachute design?
- What is one thing you would want to change about your checklist based on your observations?
- What is one thing from our other checklist that you might want to incorporate into your checklist?

4. Tell groups to answer questions 4–5 in the Analyze Data section on page 12 of Model Rocket Checklist and Data Collection document.
Tell students they will be presenting their revised checklist to an audience so that other students can learn about how to launch rockets safely. Inform students of their options for audience and format. Tell students that you will talk to each group and review their changes. Changes must have teacher approval before moving to the next step.

Circulate and ask groups about the changes that they are making to their checklist and parachute design. If groups are having difficulty getting started or don’t think changes are necessary, consider using the prompts below.

Suggested Prompts
- Did your launch and landing meet all of the criteria?
  - If not, how could you change your checklist or design to meet the criteria?
  - If yes, could you share what ideas did you get from your discussion with the other group?
- Imagine a friend or family member wanted to launch a model rocket. Are the steps in your checklist clear enough that they could use them to safely launch a model rocket?
5. **Direct groups with teacher approval to begin working on the presentation of their Model Rocket Checklist.**

   Explain to students the process for finalizing their checklist. Two options are listed below.
   
   - Teacher review, implement feedback, and final teacher review
   - Peer review, implement feedback, teacher review, implement feedback, final teacher review

6. **Facilitate the setup and sharing of the Model Rocket Checklists with the chosen audience.**

   If there will not be an outside audience, or students decided to create videos or social media posts, one option is to set up a gallery walk so half of the groups can present or share the content they created, and half can be the audience—then switch roles.