

## Storybook Theme Park Ride

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| <b>Level:</b>                             | Elementary School                                  |
| <b>Type of Contest:</b>                   | Team   |
| <b>Composition of Team:</b>               | 2–4 students per team                              |
| <b>Number of Teams:</b>                   | One entry per school                               |
| <b>Next Generation Science Standards:</b> | 3-5-ETS1-1., 3-5-ETS1-2., 3-5-ETS1-3. <sup>1</sup> |

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### Overview

The objective of this project is to expose students to the engineering process through the design and construction of a functional model theme park ride based on a storybook of the team's choosing. The ride must be designed to safely carry four "passengers" including one marble, two Ping-Pong balls, and one golf ball (provided to teams by Maryland MESA) through two consecutive test runs.

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### NOTES

**All entries must be checked in *upon arrival* at MESA Day.**

**Maryland MESA will provide the passengers (i.e., marble, Ping-Pong balls, and golf ball) to the teams. Teams should bring these passengers to the MESA day competition.**

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### Judging Guidelines

The competition is judged based on scores for each of the components described in the following sections, including design and construction, oral presentation and board display, and performance demonstration. The rubrics in the **Scoring Sheet** provide details on the scoring of each of the competition judging components with the following points for each category (100 points total):

- 1. Design and Construction:** 20 points
- 2. Oral Presentation and Board Display:** 55 points
- 3. Performance Demonstration:** 25 points

The following sections describe the requirements for each category.

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<sup>1</sup> NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press: <http://www.nextgenscience.org/next-generation-science-standards>.

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## **Design and Construction**      **20 points**

The overall design and construction of the functional model theme park ride will be judged on the following characteristics:

1. **Size (5 points)** – The complete functional model/device must be relevant to its companion book and constructed on a base no larger than 60.96 cm<sup>2</sup> (24 × 24 in.) and be no taller than 91.44 cm (36 in.) before and during operation.
2. **Passengers (5 points)** – The Storybook Theme Park Ride must be designed to safely carry only four “passengers” at a time, during two consecutive tests. The Performance Demonstration judging guidelines define what can be used as passengers. The passenger items may be decorated, but they must remain clearly visible throughout the course of the model’s activation, and they may not be fastened to the model with any type of adhesive or fully enclosed within the device.
3. **Propulsion and Launch Device (5 points)** – The model/device can be propelled by any appropriate means (e.g., pulley, electric motor, fan, etc.) and must be able to remain activated without continual physical contact from the team member(s). In other words, the model (once set up) should fully function after activation without a continual push or pull (i.e., force) from the demonstrating team member(s). A switch, lever, trigger, etc. must be part of the design to initiate launch of the vehicle, which may be activated only by brief physical contact from the team member. However, at no time should any physical action from a team member generate a force that directly contributes to the vehicle’s forward motion. The launch operation is scored during the Performance Demonstration.
4. **Original Materials and Cost (5 points)** – Any suitable materials or tools may be used in the construction/assembly of the device. Scoring emphasis will largely be placed on the device being made primarily (more than 50%) of recycled/repurposed component materials (not a kit), with the finished device costing less than 50 U.S. dollars (\$50 USD).
5. **Restrictions** – Teams may bring only one Storybook Theme Park Ride to the competition.

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### **NOTE**

**All entries must be checked in *upon arrival* at MESA Day.**

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## **Oral Presentation and Board Display** **55 points**

Each team will be assigned a setup location at MESA Day. In this location, student team members will give a 2- to 7-min oral presentation, provide functional model/device demonstrations, and answer judges' questions about their device. Additionally, students will explain how their model/device reflects the theme of the selected storybook from which they drew its inspiration. All student members should actively participate in the presentation.

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### **NOTE**

**Participation in the presentation or interjections by adults of team members are not permitted during the presentation.**

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#### *Display Board Requirements*

The team's design presentation must be accompanied by a tri-fold display board, 48 x 36 in. (W x H), that contains the following information:

1. **School Name or School System Name.**
2. **MESA Advisor(s) and Principal's Names.**
3. **Team Members and Their Roles** – Display board introduces all team members and their contributions to the project.
4. **Graphic Display** – A well-labeled graphic of how the model functions.
5. **Description of the Selected Storybook** – A brief description of the storybook the team employed should include the following:
  - Title, Author, Illustrator, Year First Published, Genre, Plot/Narrative, Moral/Lesson.
  - Reasoning for selecting this particular book.
6. **Engineering/Design Process** – The team should describe the process they used to design and engineer the ride, including the following:
  - How the design was tested and selected (including sketches of the original design).
  - What improvements or changes were made to the design and why.
  - A complete (but brief) description of some of the problems the team encountered in designing the ride and how they resolved those problems.
7. **Bibliography** – List at least six resources used to solve the challenge problem. Include books and websites. Reference citations must be formatted according to the American Psychological Association (APA) style for reference citations.<sup>2</sup>

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<sup>2</sup> Available at: <http://www.apastyle.org>.

8. **Materials** – List all the component materials of the device. Indicate the cost of each item. Estimate the value of donated materials. At the bottom of this list, provide a total cost of all component materials used in the device, which must be less than \$50 (U.S. Dollars). See the [Example Budget Sheet](#).
9. **MESA Logo** – Include the JHU/APL MD MESA logo, no smaller than 3.79 x 1.5 in., in the upper right corner of the display. The logo can be downloaded from the MD MESA website: [www.jhuapl.edu/mesa](http://www.jhuapl.edu/mesa).

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### *Example Budget Sheet*

The following is an example of an itemized sheet listing each component and its cost:

| Item              | Quantity | Cost (\$)    |
|-------------------|----------|--------------|
| • Popsicle Sticks | 200      | 4.00         |
| • Marbles         | 2        | 2.00         |
| • Motor           | 1        | 5.00         |
| <b>TOTAL:</b>     |          | <b>11.00</b> |

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### **NOTE**

Donations must be assigned a value and included the budget sheet calculation. Receipts and/or descriptive purchase documentation must be provided for all items.

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### *Judges' Questions*

All students are required to discuss and answer questions from the judges on the design process and the role they played in the creation of the Storybook Theme Park Ride. Responses to judges' questions will be factored in to scoring for all categories. Judges may ask questions at any time during the competition. The judges' questions may be centered on—but not limited to—the following:

1. Why the storybook theme was selected and how the model connects to the story.
2. Reason for the selected design for the model's automated movement.
3. The scientific research required to construct a fully automated device.
4. The team's selection of recycled/repurposed materials.
5. How the design was tested and what improvements were made (Engineering Process).
6. Steps taken to ensure the safety of passengers without adhesives (glue, Velcro, etc.) or enclosure (sealed lids, domes, etc.).

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## **Performance Demonstration 25 points**

The following are the judging requirements for the Performance Demonstration. The rubrics in the [Scoring Sheet](#) provide details on the scoring of each of the following requirements.

**“Three Count” and Launch (5 points)** – Once the ride is set up, the student should give a “three count,” during which time the ride must not be in activation and the team members are not in contact with the model/device. Once the “three count” is completed, the switch, lever, trigger, etc. may be activated to initiate the device by brief physical contact from the team member.

**No Physical Contact (5 points)** – At no time should any physical action from a team member generate a force that directly contributes to the vehicle’s forward motion.

**Passengers** – The Storybook Theme Park Ride must be designed to safely carry the following items, also referred to as “passengers”, for two consecutive test runs:

1. One marble
2. Two Ping-Pong balls
3. One golf ball

Maryland MESA will provide teams with the passengers. Inclusion of all four passengers is scored in the Design and Construction rubric. The following are the requirements for the passengers scored during the Performance Demonstration:

**1. Set up Next to the Device (5 points)** – The passengers must remain next to the model/ride before its demonstration and only placed into the ride in the sight of the judges before testing begins.

**2. Passenger Visibility and Safety (5 points)** – The passengers may be decorated, but they must remain clearly visible throughout the course of the model’s activation, and they must remain safely in the ride for both runs without falling out.

**3. No Fasteners (5 points)** – The passengers may be secured during testing, but they may not be fastened to the model with any type of adhesive or fully enclosed within the device during the performance demonstration.

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### **NOTE**

**Teams should bring the passengers provided by Maryland MESA to the MESA day competition.**

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## **Bonus Points**                      **15 points**

To distinguish themselves, teams can earn additional points for completing one or more of the following bonus design challenges. Each completed bonus challenge is worth an additional 5 points:

- Loading passengers into the device without direct physical contact in under 1 minute.
- Activating the device via a wireless remote.
- Starting the passengers (once loaded in the device) below 7 in. and taking them above 20 in. (while still in device).

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## **Tie-Breakers**

Ties will be broken via the use of the highest score on the following predetermined rubric indicators:

|  |                  |
|--|------------------|
| <b>Design and Construction</b>             | <b>20 points</b> |
| <b>Oral Presentation and Board Display</b> | <b>55 points</b> |
| <b>Performance Demonstration</b>           | <b>25 points</b> |

The **Scoring Sheet** itemizes possible points for each tie-breaker category.

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**ALL DECISIONS MADE BY JUDGES ARE FINAL.<sup>3</sup>**

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**All MESA teams are encouraged to enter the Maryland Engineering Challenges, from which this challenge draws its inspiration.**

**For more information, visit the Engineering Challenges page on the Baltimore Museum of Industry website: <http://www.thebmi.org/>**

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<sup>3</sup> If a team believes an error was made that affected the outcome of the competition, the team's advisor may submit an appeal form. These forms will be available on the day of the competition.

School: \_\_\_\_\_ Judge: \_\_\_\_\_ Total: \_\_\_\_\_ points

| Performance Area  | Level of Mastery (Select One) |            |             |      |         | Total                          |
|---|-------------------------------|------------|-------------|------|---------|--------------------------------|
|   | None                          | Developing | Approaching | Some | Mastery |                                |
| <b>Storybook Theme Park Ride Challenge</b>  |                               |            |             |      |         |                                |
| <b>Oral Presentation and Board Display – TIE-BREAKER 1</b>  |                               |            |             |      |         |                                |
| <b>Students significantly increase the judges' understanding of the team's approach to the engineering and design process—including but not limited to the following:</b>   |                               |            |             |      |         | <b>Section Total 55 Points</b> |
|   |                               |            |             |      |         | _____ /55                      |
| ➤ <b>Insight</b> – The presentation/display board offered a highly insightful view into how the ride's design was tested and selected (including sketches, if applicable).  | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Academic Rigor</b> – The team presented a complete (but brief) description of some of the problems they encountered in assembling and/or designing the ride and how those problems were resolved.  | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Sources</b> – The presentation/display board includes at least six cited sources used to assist the team in solving the stated problem (formatted using APA style for reference citations). <sup>4</sup>   | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Team Member Contributions</b> – The team introduced all of their team members and detailed the contributions of each on the display board.   | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Organization</b> – Utilizing their display board, the team delivered a brief, engaging introduction, a uniquely interesting presentation, and a highly compelling conclusion.  | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Display Board</b> – Professionally assembled and utilized through key features of the oral presentation. Includes the JHU/APL Maryland MESA Logo in the upper right corner. The board should be the required size of 36 x 48 in. and include a list of component material costs totaling less than \$50 USD. | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Professionalism</b> – Clear speech (avoids "Umm," "Like," "You know," etc.), good eye contact, professional posture.   | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Accurate Timekeeping/Pacing</b> – Team presented within the 2- to 7-minute window without rushing or going too slow.   | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Working Knowledge</b> – Student conversations allow judges to readily assess that the students were highly involved in the engineering and design process and that their ideas came to life in the device.   | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Creativity and Imagination</b> – The design is highly imaginative and takes creative risk without losing functionality.  | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| ➤ <b>Relevance</b> – The presentation demonstrates a clear connection and relevance to the Storybook theme.   | (1)                           | (2)        | (3)         | (4)  | (5)     | _____ /5                       |
| <b>Continued...</b>   |                               |            |             |      |         |                                |

<sup>4</sup> Available at: <http://www.apastyle.org>.

School: \_\_\_\_\_ Judge: \_\_\_\_\_ Total: \_\_\_\_\_ points

***Judge's Feedback for the Oral Presentation and Board Display***

Large empty rectangular box for feedback.

School: \_\_\_\_\_ Judge: \_\_\_\_\_ Total: \_\_\_\_\_ points

| Performance Area  | Level of Mastery (Select One)  |              | Total    |
|---|--------------------------------|--------------|----------|
|   | Not Demonstrated               | Demonstrated |          |
| <b>Storybook Theme Park Ride Challenge (Continued)</b>  |                                |              |          |
| <i>Design and Construction – TIE-BREAKER 2</i>  |                                |              |          |
| <i>Student team demonstrates a command ability to discuss factual, relevant information about their topic—including but not limited to the following:</i>   | <i>Section Total 20 Points</i> |              | _____/20 |
| ➤ <b>Size</b> – The device is no larger than 24 x 24 in. and is not taller than 36 in. before and during operation.   | (0)                            | (5)          | _____/5  |
| ➤ <b>Passengers</b> – The device is designed to safely carry all four “passengers” at a time, during two consecutive tests. The passenger items remain clearly visible throughout the course of the model’s activation, and they are not fastened to the model with any type of adhesive or fully enclosed within the device.   | (0)                            | (5)          | _____/5  |
| ➤ <b>Propulsion and Launch Device</b> – Device propulsion design is elegant, and activation does not require direct, continual physical force from an operator. A switch, lever, trigger, etc. is designed to initiate launch of the vehicle, is activated by brief physical contact from the team member, but never requires physical action from a team member to generate a force that directly contributes to the vehicle’s forward motion. | (0)                            | (5)          | _____/5  |
| ➤ <b>Original Materials and Cost</b> – Model/device was clearly made primarily (50% or more) from recycled/repurposed materials (not a kit).  | (0)                            | (5)          | _____/5  |

**Judge’s Feedback for Design and Construction**

School: \_\_\_\_\_ Judge: \_\_\_\_\_ Total: \_\_\_\_\_ points

| <b>Performance Demonstration – TIE-BREAKER 3</b>   |   |     |         |
|--|---|-----|---------|
| <b>Student design demonstrates the following performance requirements:</b>   | <b>Section Total 25 Points</b> _____/25 |     |         |
| ➤ <b>“Three Count”</b> – Placing the device on the line, the student gives a “three count” on both runs/trials without fail before activation of the device.   | (0)                                     | (5) | _____/5 |
| ➤ <b>No Physical Contact</b> – When the run is initiated, the team member launching the device demonstrates that he or she does not maintain constant direct physical contact with the device while launching it, and the device can remain fully functional after activation. | (0)                                     | (5) | _____/5 |
| ➤ <b>Passengers Requirement 1</b> – Passengers were set up next to the device before loading and loaded in judges’ sight.  | (0)                                     | (5) | _____/5 |
| ➤ <b>Passengers Requirement 2</b> – Passengers remained safely in the ride for both runs/trials without falling out.   | (0)                                     | (5) | _____/5 |
| ➤ <b>Passengers Requirement 3</b> – Passengers were restrained without full enclosures or adhesives.   | (0)                                     | (5) | _____/5 |

**Judge’s Feedback for the Performance Demonstration**

School: \_\_\_\_\_ Judge: \_\_\_\_\_ Total: \_\_\_\_\_ points

| <b>Bonus Points</b>  |   |
|--|---|
| <b>Add 5 points for each of the following bonus tasks completed:</b>   | <b>Bonus Section Total 15 Points</b> _____/15 |
| ➤ <b>Loading Passengers</b> – Loading passengers without direct physical contact in under 1 min.                   | _____(5 points)                               |
| ➤ <b>Wireless Remote</b> – Activating the device via a wireless remote.  | _____(5 points)                               |
| ➤ <b>Starting Passengers</b> – Starting passengers below 7 in. and taking them above 20 in. (all while in device). | _____(5 points)                               |

| <b>Overall Score for the Storybook Theme Park Ride</b> |  |
|--|--|
| <b>TOTAL SCORE (x/100 points):</b> _____/100           |  |