

ROLLER COASTER RUN

LEVEL	Middle School / High School
NUMBER OF TEAMS	One (1) per school
TEAM MEMBERS	Two (2) to four (4) students

OBJECTIVE

Middle School and High School teams will design, build, test, iterate, and demonstrate a free-standing, gravity-powered roller coaster for a standard glass marble. The coaster should combine reliable engineering performance with identifiable thrill elements and a creative theme that contributes to an intentional ride and guest experience.

MATERIALS

Teams may use a variety of commonly available construction and craft materials. Premanufactured roller coaster, race-track, marble-run, or construction kits may not be used as structural or track components. Decorative or thematic components from commercial products may be used when they do not solve the engineering challenge.

- Examples include lightweight wood, wooden dowels, cardboard, paper tubes, pipe insulation, plastic tubing/PVC pipe, wire, string, straws, paper clips, straight pins, assorted tape, rubber bands, craft sticks, staples, and Styrofoam.

DESIGN PARAMETERS

1. The design must be free-standing and mounted on a flat base.
2. The complete design and base must fit within a 70 cm × 70 cm × 70 cm box.
3. The complete design, including the base, may not exceed 10 kg.
4. The roller coaster must include its title, school name, and team member names on the coaster or base.
5. The coaster must incorporate at least two distinct, identifiable thrill elements. Examples include loops, corkscrews, sharp turns, steep drops, airtime hills, spirals, or other features that meaningfully change the marble's motion.
6. Teams must identify their thrill elements for judges. Additional elements do not automatically earn additional points.
7. Teams must creatively incorporate a defined theme. Theme scoring emphasizes integration and guest experience, not artistic skill alone.
8. Teams will use a standard 14–16 mm glass marble. Teams may bring their own marble for judge approval or use one supplied by the host site.
9. The marble must travel through the intended course under gravity. A team member releases the marble from the designated starting position without pushing or otherwise adding force.
10. The marble must remain on the track throughout the intended course and must come to a complete, controlled stop on the track at the end of a successful run.

SPECIFICATION & SAFETY CHECK

Before official runs, each coaster must pass a specification and safety check. Judges will verify:

- Free-standing design mounted on a flat base.
- Complete design fits within 70 cm × 70 cm × 70 cm.
- Total weight is 10 kg or less, including the base.
- No premanufactured kits are used as structural or track components.
- Coaster title, school name, and team member names are included.
- At least two distinct, identifiable thrill elements are present.
- A defined theme is incorporated.
- A standard 14–16 mm glass marble is approved or available.
- The design is safe to operate and handle.

A design judged unsafe may not operate until the safety issue is corrected and the coaster passes reinspection. If a team cannot meet a non-safety specification requirement after the correction opportunity provided by event officials, the team will receive zero performance points but remains eligible for Engineering Design Poster points. Serious or intentional rule violations may result in full disqualification at the discretion of event officials.

OFFICIAL RUNS & TESTING

1. Designs that pass specification and safety check will be placed on a flat, level testing surface.
2. Each team receives three (3) official runs.
3. A successful run is one in which the marble is released without a push, travels through the team's intended course under gravity, remains on the track, reaches the designated finish, and comes to a controlled stop on the track.
4. A run is unsuccessful if the marble leaves the track, becomes permanently stalled, or otherwise fails to complete the intended course.
5. Reliability points are based on the number of successful official runs.
6. Ride Duration points are based on the average duration of successful official runs only.
7. A minimum of two team members must be present to demonstrate and briefly discuss the design with judges, including identifying the thrill elements and theme.

BETWEEN-RUN REPAIRS

After Runs 1 and 2, teams may use up to 60 seconds to inspect, repair, reinforce, or adjust the coaster before the next official run. Teams may proceed sooner when ready. Repairs may restore or stabilize the existing design, but teams may not substantially redesign the coaster, add new thrill elements, or replace major sections between official runs.

SCORING

Category	Points
Engineering Performance	30
Thrill Design	20
Innovation & Creativity	15
Theme & Guest Experience	10
Engineering Design Poster	25
TOTAL	100

ENGINEERING PERFORMANCE - 30 POINTS

Reliability - 15 points

Successful Official Runs	Points
3 of 3	15
2 of 3	10
1 of 3	5
0 of 3	0

Ride Duration - 10 points

Average Duration of Successful Runs	Points
22–30 seconds	10
19–21.99 seconds	8
16–18.99 seconds	6
13–15.99 seconds	4
10–12.99 seconds	2
Under 10 seconds	0
Over 30 seconds	0

Engineering Execution - 5 points: Judges evaluate controlled movement, effective transitions and energy management, structural stability during operation, and a controlled finish.

THRILL DESIGN - 20 POINTS

Criterion	Points	What Judges Consider
Successful Execution	8	Thrill elements function as intended during official runs.
Difficulty & Engineering Challenge	5	Elements demonstrate meaningful technical challenge.
Variety	4	Elements create different types of motion or ride experiences.
Integration into the Ride	3	Elements contribute naturally to the overall coaster.

INNOVATION & CREATIVITY - 15 POINTS

Criterion	Points	What Judges Consider
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Creative Engineering Solutions	7	Inventive or thoughtful approaches to solving engineering challenges.
Effective Use of Materials	4	Materials are used purposefully to accomplish design goals.
Originality of Design	4	The coaster demonstrates original thinking in its engineered design.

THEME & GUEST EXPERIENCE - 10 POINTS

Criterion	Points	What Judges Consider
Theme Integration	4	A clear theme is incorporated throughout the coaster rather than simply named or added as decoration.
Ride Experience	4	Track layout, thrill elements, pacing, and design work together to create an intentional experience.
Visual Communication	2	The physical coaster effectively communicates its theme and intended experience.

TL;DR

- Build a free-standing, gravity-powered marble roller coaster for a standard 14–16 mm glass marble.
- Maximum size: 70 cm × 70 cm × 70 cm. Maximum weight: 10 kg, including the base.
- Include at least two distinct, identifiable thrill elements and a defined theme.
- Three official runs determine reliability and ride-duration scoring.
- After Runs 1 and 2, teams may use up to 60 seconds for repairs, reinforcement, or adjustment, but not substantial redesign.
- Engineering Performance = 30 points; Thrill Design = 20; Innovation & Creativity = 15; Theme & Guest Experience = 10; Engineering Design Poster = 25.
- Poster = 36 in high × 48 in wide, landscape, submitted as a PDF by 5:00 p.m. at least two weeks before MESA Day.

READ THE FULL SPECIFICATIONS. The TL;DR is a quick reference and does not replace the complete rules.



ENGINEERING DESIGN POSTER - 25 POINTS

Each team will submit one digital Engineering Design Poster. The poster should communicate the engineering story of the coaster rather than simply decorate or describe the finished design.

- Size: 36 inches high × 48 inches wide.
- Orientation: Landscape.
- Submission: Digital PDF.
- Deadline: 5:00 p.m. at least two weeks before MESA Day. Arizona MESA will announce the specific date and submission process.
- Include: project/prototype name, school name, team member names, school logo, and MESA logo.
- Organize the engineering content around Explore → Design → Test → Iterate.

Poster Template: [Arizona MESA Engineering Design Poster Template](#). Use of the template is recommended, but not required.

Poster Area	Points	Evidence Expected
Explore	5	Understanding of the challenge, criteria/constraints, investigation, and ideas considered.
Design	5	Selected approach, planned/built prototype, and key design decisions.
Test	6	Testing methods, relevant data/evidence, and what the team learned from results.
Iterate	6	Changes informed by evidence, retesting/evaluation, and explanation of improvement or next steps.
Communicate	3	Clear, organized communication that helps judges understand the engineering work.



FINAL SCORE

Engineering Performance (30) + Thrill Design (20) + Innovation & Creativity (15) + Theme & Guest Experience (10) + Engineering Design Poster (25) = 100 points

JUDGE SCORESHEET

School Name: _____

Team Members: _____

Coaster Title: _____

Judge: _____

Score Component	Score
Engineering Performance	_____ / 30
Thrill Design	_____ / 20
Innovation & Creativity	_____ / 15
Theme & Guest Experience	_____ / 10
Engineering Design Poster	_____ / 25
FINAL SCORE	_____ / 100

OFFICIAL RUN RECORD

Run	Successful?	Time	Notes
1	Yes / No	_____ sec	
2	Yes / No	_____ sec	
3	Yes / No	_____ sec	
Average of successful runs		_____ sec	