Academic Rodeo
Engineering Challenge

Competition Guide

Revised August 2021

Contents

Engineering Challenge was created as a cooperative effort between The Park of East Texas Academic Rodeo and STEM initiatives at The University of Texas at Tyler, currently operating as The Ingenuity Center.

Engineering Challenge Overview

The Engineering Challenge has been designed to meet National Science Education Standards and facilitate abilities in technological design while providing a foundation for understanding science and technology. It is modeled after the Engineering Challenge and Engineering Challenges and uses resources from these programs. **Students must work as a Team using the engineering design process and be able to clearly communicate the design process to others.** The Engineering Challenge requires a high level of both teacher and student dedication. Parents can also be a strong support to the Team.

See **Engineering Challenge Rules** document for the contest's rules and **Engineering Challenge Tips** for suggestions to assist in preparing Teams for competition.

This is a student project. Coaches and other adults are encouraged to assist in an advisory capacity and offer suggestions for the development of the project. However, ultimately, the entire project should be the work of the students. At the contest, the students are in charge of the project. and any adults must take on an observational role ONLY. Adults will be asked to move away from weigh-in stations, presentation table, and the Rover course, if they become involved in the presentation or completion of the course in any way.

The Lego kit supplied is the primary source for building materials. The kit is checked out to the Team and the Team is responsible for inventorying at the end of the competition to see that all parts are returned. Failure to return the kit in a timely manner or obvious missing components will result in an invoice to the school or group to replace the kit.

Other Information and Resources are available in the Teacher Activity Book, Student Activity Book, and Scoring Forms.

Engineering Challenge Competition Checklist

Before attending the Engineering Challenge Competition, review the following checklist to ensure that the Team is prepared for competition and has completed all the necessary requirements:

____ The Engineering Team is composed of **four** members currently in the grades assigned to the competition level entered.

____ The Engineering Team has a teacher sponsor from the same school district.

____ The Team's Mars Rover has a rock collection device that does not operate manually and has a rock storage area.

____ The Team's Mars Rover does **NOT** have three motors AND three battery boxes, or non–LEGO® power sources (three motors OR three battery boxes are allowable).

____ The Team's Mars Rover is constructed using only the provided LEGOs®, up to $75 in additional LEGOs®, and items on the "non-LEGO® Allowable Elements" list.

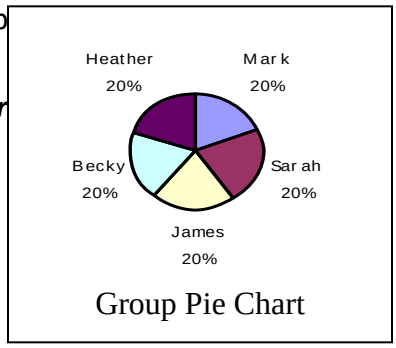
____ The Team's Mars Rover is fully intact and ready for competition, as it cannot be modified ***in any way*** at the competition. Repairs may be done when there is a catastrophic breakdown, but the Rover must be returned to its original design.

____ The Team has selected a Rover Driver (*different Driver for each event*), Rover Assistant and Emergency Mechanic for each of the four driving events.

____ The Team has prepared a Poster Presentation that is no more than 6 minutes in length and has selected a Team spokesperson to lead the Poster Presentation.

____ The Team has prepared a display that demonstrates the Engineering Design Process and contains a group pie chart.

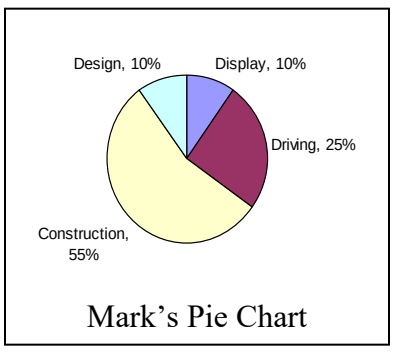
____ The group pie chart should display the percent of time each memb
overall process *(see example below).*



Group Pie Chart

____ The Team has prepared a Lab Notebook that contains ***in this order***

- ❖ Responsibilities Document (signed by all)
- ❖ Team Timeline
- ❖ Team Checklist
- ❖ Day-to-day entries, labeled, and handwritten about design
- ❖ Three separate, itemized budgets:
  - Additional LEGO® Components*(no more than $75)*
  - Non – LEGO® Allowable Elements
  - Poster Display *(no more than $50)*
- ❖ Individual Pie Charts depicting what components each Team member completed, and how much time was dedicated to each component *(see example at right)*
- ❖ A short paper describing what was learned in the Team's research about Mars and how this affected the design.
- ❖ Any activities completed from the Student Activity Book



Mark's Pie Chart

✦If it is discovered through review of the budget or review of the Rover's extra components that a Team has expensed more than $75 on additional LEGOP® components or more than $50 on the poster display, **the Team will be automatically disqualified.**

Engineering Design Process

The following is the engineering design process which all Teams should observe. This process must be reflected in the Mars Rover display and presentation created by each Team, as well as the required Lab Notebook which each Team must maintain throughout its participation in the Academic Rodeo Engineering Challenge.

1. **Identify the problems.** This step should include general statements or questions which correlate with the testing criteria such as "How might a Rover store rock samples which it collects from the ground?" More specific problems will likely be identified as a Rover is being constructed, and these problems will be addressed via the testing and revising of Rover design.

2. **Set your goals.** The goals set by the Engineering Team should be as specific as possible and should address the general problems they initially identified. One goal could be stated as follows: "Our Rover will be able to store a minimum of 10 rock samples."

3. **Brainstorm design ideas.** The key to brainstorming is to remember that no idea is a bad idea! Each idea, no matter how off-the-wall it seems, should be recorded during the brainstorming session. Encourage the students to be creative, because the more ideas that are generated, the more likely it is that a successful design will result. Brainstorm sessions may be carried out individually or as a group.

4. **Select and construct a design.** After the brainstorming phase, the group should decide which ideas it likes best, and then construct a prototype which incorporates these ideas into its design.

5. **Test and revise your model.** After an initial prototype has been constructed, it must be thoroughly tested to ascertain both its strengths and its weaknesses. Most likely, you will discover that some ideas which you thought were absolutely wonderful didn't work at all. At this stage, you should consider more specific problems, such as "Why do the collected rocks fall out of the Rover every time it goes up a hill?" The Team must then begin brainstorming ways to deal with the problem and/or incorporate one or more of the alternate ideas which were brainstormed earlier. The process of testing and revising will undoubtedly have to be carried out many, many times in every area of your Rover design.

6. **Present your final product.** After your Rover has been exhaustively tested and countless revisions have been carried out to create a working vehicle, it is time to show everyone your creation! Participation in the Engineering Challenge, and especially the creation of a display and presentation for your Rover, will provide others with the opportunity to admire the results of your labor.

Engineering Challenge
LEGO Sources

There are two sources for purchasing additional LEGO components which are divisions of the same company.

LEGO and LEGO Education
PitscoDacta – educational – limited brick options

Each Team is allowed **$75** in additional LEGOs for their rover.

LEGO bricks can be ordered from **https://LEGO.com/en-us**, Shop, then Pick-a-Brick page.
Also, shop at LEGO Education – **https://education.lego.com/en-us**
LEGO bricks, tires, etc. can also be found on eBay and Amazon. Be sure they are LEGO products, not knock-off brands.

It may take several weeks to receive parts from LEGO. Students should carefully consider what is needed prior to ordering extra LEGO parts. They will likely find the need for more gears since considerable gearing is needed to increase the turning power of the LEGO motors. Extra axles, pneumatics, or tires may also warrant strong consideration.

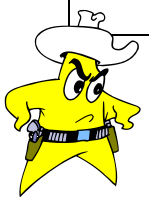
Lesson plans, resources, and LEGO products can also be found at **https://education.lego.com/en-us**.
NOTE: You are NOT limited to what you find in the pages you view below. These pages are designed to help you get started in locating other LEGO components for the Team's Rover.

Engineering Challenge
Non - LEGO® Allowable Elements

ELEMENT	*DEFINITION*
Cardboard	A cardboard product of varying qualities ranging from paperboard to corrugated
Fasteners & Adhesives	An item used to attach or bond one item to another *(Do NOT glue or damage provided LEGO® pieces)*
Paper	A paper product in varying thicknesses ranging from tissue paper to matte board
Springs	A metal or plastic coil
Metal	*Containers*: An aluminum or tin container *(steel containers are NOT allowed)* *Wire*: A pliable metallic strand in varying diameter ranging from twist ties and paper clips to cable *(may NOT be used as an electrical component)* *Sheets*: A flat, pliable metal product in varying thicknesses ranging from aluminum foil to sheet metal *(Steel is NOT allowed)*
Wood	A raw wood product and/or any finished wood product and/or wooden component of a finished product

ELEMENT	*DEFINITION*
Fabric	A cloth, vinyl, or leather material
Foam	A light, porous, semi-rigid, or spongy material used for insulation or shock absorption
Rubber	A pliable, elastic-like material ranging from rubber gloves to a tire
Tethers	A rope, chain, or similar device varying from fishing line to strapping
Plastic	*Bags*: A plastic bag in varying thicknesses ranging from a sandwich bag to a bedding bag *Containers*: – A plastic item used as a storage device *Cylinders*: – A plastic pipe, straw and / or open-ended tube *Utensils*: – Tools used in eating or food preparation *Sheets*: – A flat plastic product in varying thicknesses ranging from plastic wrap to a tarp

☆ ***Remember*** *– tubing and rubber bands are considered part of the "Additional LEGO® Components" budget*



Any Non - LEGO® Element NOT on the above list is NOT allowed in the final Rover design. The Engineering Challenge Contest Coordinator will be the final determinate on what constitutes an allowable and unallowable item in the Rover design.

Include this form in Notebook.

Engineering Challenge
Responsibilities of Coaches and Participants

This form should be signed by all individuals involved and **included in the Lab Notebook**.

Responsibilities of Sponsor/Coach

1. Schools choosing to use a parent as the sponsor/coach must also have a designated sponsoring teacher to serve as a liaison between Academic Rodeo and the school.
2. The sponsoring teacher must be from the same school district as the Engineering Team.
3. Since the Engineering Challenge is intended to be a student-driven competition, **no teacher or parent is allowed to construct or assist in the construction of any portion** of the Mars Rover model or display.
4. A maximum of two sponsors/coaches may be used for each Team, but a single coach may serve as the sponsor for more than one Team when the School/Group has Elementary AND a Middle School Teams.
5. The primary responsibilities of the sponsor/coach include teaching applicable science and engineering concepts to the students, presenting guiding questions, making sure that construction guidelines are followed, and aiding in the organization of the Team. Coaches and all other advisors must be observers ONLY at the contest, allowing students to be in control of their participation. Any questions regarding the appropriate participation of the sponsor/coach should be directed to the Academic Rodeo Director.

_____ Teacher/Sponsor Signature

_____ Teacher/Sponsor Signature

Responsibilities of Team

1. All Engineering Team members must currently be in one of the grades for their competition level – Elementary (grades 3-5) or Middle School (grades 6-8).
2. All Engineering Team members must be from the same school campus.
3. Each Engineering Team must consist of 4 students.
4. Only members of the Engineering Team are allowed to participate in the actual construction of the Mars Rover model and display.
5. Only members of the Engineering Team are allowed to control the Rover at competition.
6. Only members of the Engineering Team are allowed to advise a Rover driver during the various Rover tests at the Competition.
7. Each Elementary Team is allowed a maximum of two "Technical Advisors" who are students in grades 7-12. Technical Advisors are an optional part of a Team, **not mandatory**.
8. Each Middle School Team is allowed a maximum of two "Technical Advisors" who are students in grades 9-12. Technical Advisors are an optional part of a Team, **not mandatory**.
9. Each Team must have at least one facilitating sponsor/coach.

_____ Team Member Signature

_____ Team Member Signature

_____ Team Member Signature

_____ Team Member Signature

Responsibilities of Technical Advisors

1. All Technical Advisors must currently be students in grades 7-12 if working with an Elementary Team or in grades 9-12 if working with a Middle School Team.
2. Technical Advisors must be from the same school district as the Engineering Team.
3. A maximum of two Technical Advisors may be used for each Team.
4. No Technical Advisor is allowed to directly assist in construction of the Mars Rover model or display.
5. Technical Advisors are intended to serve as mentors of the Engineering Team. They will bring additional experience to the engineering tasks and will be an invaluable resource. However, it should be remembered that each contest level is designed for specific grades and the final product should be their work. Advisors may provide input and feedback to the Engineering Team, but the Engineering Team itself should be responsible for the overall prototype design and refinement. At the contest, any technical advisors in attendance are to observe ONLY and allow all work and activity be done by the students alone. Any questions regarding the appropriate participation of Technical Advisors should be directed to the Academic Rodeo Director.

_____ Technical Advisor Signature

_____ Technical Advisor Signature

Parent Participation

1. Parent participation is a vital part of the competition.
2. A parent may serve as the sponsor/coach but must work with a sponsoring teacher from the school.
3. Students are encouraged to talk to parents and others regarding their efforts at designing a Mars Rover model. However, parents **should NOT** tell students how to design their Rover but should be available to answer questions which students may have.
4. It is the sponsoring teacher's responsibility to insure that any parent participation is within the guidelines provided. No parent is allowed to construct or assist in the construction of any portion of the Mars Rover model or display. At the contest, **IF allowed to attend**, all adults are to observe ONLY and allow all work and activity be done by the students alone. Any questions regarding the appropriate participation of parents or other individuals should be directed to the Academic Rodeo Director.

_____ Parent Signature

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Engineering Challenge Contest
The Challenge

Design Brief: After the successful Mars Pathfinder mission in 1997 and Mars Odyssey mission in 2001, NASA realized that some modifications needed to be made for upcoming Mars missions, when further research would be conducted on the chemical make-up of Mars. Twin rovers, Spirit and Opportunity, landed on Mars January 3 and January 24, 2004, traveling to Mars to further investigate the surface. Both rovers lived well beyond their planned 90-day missions. Opportunity worked nearly 15 years on Mars and broke the driving record for putting the most miles on the odometer.

As members of the elite NASA Engineering Corp, your team is one of the groups to continue improving the Rovers to be used in future missions to traverse the rugged landscape of the Red Planet. Keep in mind that the terrain consists of large sand dunes created by great dust storms that periodically sweep the planet, innumerable rocky hills and valleys, and other demanding terrain.

Challenge: Using any or all of the materials supplied in your LEGO kit, as well as any element included on the **Non-LEGO Allowable Elements** list, construct a Mars Rover which will be able to navigate the challenging Martian terrain. Only the listed elements may be used in construction of the Rover models. NASA also requires Rovers to be as lightweight as possible to ease its transport to Mars.

The vehicle must be able to collect rock samples. For testing the Rover models, nothing smaller than a marble or larger than a golf ball will be used to represent Martian rocks. The rocks will collect will have a rough-like texture and weigh similar to Mars rocks in a "near-zero" gravity environment.

Due to budgetary concerns being expressed by Congress and following sound scientific research protocols, you **MUST** maintain a lab notebook of your team's work. The lab notebook must have dated entries and must OUTLINE your work as you approach your task through the **Engineering Design Process**. Your lab notebook is a record of the work your team does on your rover. Your team should find a binder notebook and add paper to keep track of your progress. It is NOT to be a typed "paper" produced at the end.

Engineering Challenge
Rover Construction and Display

1. LEGO kits are available for check-out through Academic Rodeo for the contest. Schools/Groups are responsible for returning all components to the Academic Rodeo Director within 1 month after the Awards Celebration.
2. A maximum of $75 may be spent on any additional LEGO parts. For ordering information, see the LEGO Information Page. Funds for these elements are the responsibility of the Team. Any extra items purchased will be kept by each Team at the conclusion of the competition.
3. If a Team has access to extra LEGO parts without having to order them, they are allowed to use these in the Rover construction; however, **these parts must be valued in the $75 LEGO budget as if they were purchased new.** The Contest Coordinator from UT Tyler will be the final determinate of the estimated value of the piece(s). If you have questions, please contact the Academic Rodeo Director. The final Mars Rover model may use any or all the supplied LEGO gears, motors, pneumatics, and other pieces.
4. Each Mars Rover may use no more than three LEGO motors or battery boxes. This means a maximum of 3 batteries and 2 motors, or 2 batteries and 3 motors can be used. Extra pneumatic pistons or pumps are permissible within the $50 LEGO budget.
5. Additional Non-LEGO Allowable Elements NOT included on the Non-LEGO Allowable Elements list are not permissible in the construction of a Rover model (including Construx, etc.). Non-LEGO Allowable Elements are the responsibility of each Team.
6. There is no budget limit for expenses associated with the use of Non-LEGO Allowable Elements or other miscellaneous expenses such as batteries; however, please note that it is assumed that Teams will use recycled or common, inexpensive household items as their Non-LEGO Allowable Elements.
7. **PLEASE do NOT glue together** any of the LEGO pieces from the provided starter kits. These kits are reused each year. Other means of strengthening designs must be found if you are experiencing difficulties with the LEGO pieces staying connected. Tape may be used. If desired, it is acceptable to glue together LEGO pieces which your Team has purchased as part of its $75 LEGO budget.
8. Control of the Rover must all be remote, using the LEGO battery boxes supplied and the pneumatics. In other words, the design cannot require the controller to flip a wire or string to steer the Rover.
9. Each Team should arrive to the contest with its Rover assembled and ready to compete.
10. The display may take up a space no larger the 3’ wide x 2 ½” deep x 4’ high.
11. A maximum of $50 may be spent for materials associated with the construction of a Team’s Mars Rover display and presentation. This budget includes the value of poster board, paint, photographs, wood, or any other display construction expenses. Please note that NO computers, video equipment, etc. may be used as presentation media. You may use computers to develop your display, but you may not use the computer, videos, TV, etc. during the actual presentation at the contest.

Engineering Challenge Rover Testing

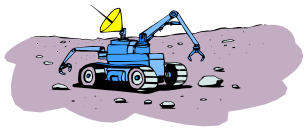
1. The Engineering Team must select different drivers to control the Rover for the four separate tests.
    - **Hill climb test**, with the objective being to climb the steepest incline possible
    - **Martian rock collection test**, with the objective being the successful collection and storage of as many rock samples as possible
    - **"Blind Driving" Teamwork test**, with the objective being that the Rover driver will successfully negotiate the Mars Test Course while blind-folded and being given course directions by the designated Rover Assistant.
    - **Rover speed test**, with the objective being to complete the course in the fastest time possible

    No individual may control the Rover for more than a single test unless every other Engineering Team member present at the competition has also driven the Rover for one of the tests. This will allow as great participation as possible by all Team members present.
2. The designated Rover driver will be able to walk beside the Rover at all times during each test.
3. One member of the Engineering Team must be selected as **Rover Assistant** for each portion of the testing. This task may be assigned to one individual for most tests or a different individual for each of the different tests. This individual will be with the Rover Driver during the testing and is responsible for aiding the driver should the Rover turn over or become stuck. (Engineering Challenge staff will help provide guidance to the Rover Assistant if such situations arise.). The Rover Assistant is the only Team member who is allowed to physically handle the vehicle during the test.
4. It is our desire that every participating Team have the opportunity to complete the Rover testing. We also understand that unforeseen problems sometimes arise. With this in mind, one Engineering Team Member should be designated as Emergency Mechanic for each portion of the testing. This task may be assigned to one individual for all tests or a different individual for each of the different tests. In the case of catastrophic breakdown during the testing, the Emergency Mechanic will be allowed to make necessary repairs, and the Rover Driver will be given one more chance to complete the test. Minor repairs will be done in "real time" with a running clock.
5. Only one opportunity for major repairs will be given to a Team for each test. Once a Team has had the clock stopped due to a catastrophic breakdown, any further repairs needed during the rerun of the test must be conducted with a running clock.
6. Teams will be penalized if they must rerun a test due to a catastrophic breakdown. (See Scoring of Mars Rover)
7. No modifications may be made to a Rover once a Team has arrived for the contest.
8. No changes may be made to a Rover for the different tests. For example, a Team my not remove a top-heavy crane for its hill climb test.
9. Each Rover must have a device designed to collect and store rock samples that does not require manual operation (i.e., requires an individual to pull a string or push a lever back and forth), even if the Rover does not successfully collect any rocks on the Mars Test Course.
10. Each Team must submit a Team name prior to the contest to ensure no duplicate Team names. Each Team will then use its registered name throughout the contest. A "Best Team Name" will be voted on by all judges at the competition and will be recognized.

Engineering Challenge Scoring

Scoring of the Mars Rover will be carried out in seven areas. The Composite Score of these seven areas will determine the 1st, 2nd, and 3rd Place Teams in each level. Following are the seven scoring areas, and their respective contributions to the composite score.

Event	Objective	Points
Rover Speed	Complete the course in the fastest time possible	10
Martian Rock Collection	Collect and store five differently colored rock samples	15
Hill Climb	Climb the steepest incline possible	10
Blind Driving	Complete the course while blind-folded through navigational instruction provided by a designated Rover Assistant	10
Rover Weight	Rover is to be as lightweight as possible	10
Rover Display & Presentation	Poster display and verbal presentation of Rover design, Rover construction process and Teamwork distribution	25
Lab Notebook & Budget	Detailed, handwritten account of Team's design process	20
	Maximum Composite Score	100 points



Overview of Scoring Requirements

1. **Mars Rover Weight (10 points):**
   The Rover needs to be as lightweight as possible, and more points will be awarded for lighter designs. The score received is 10% of the composite score, the objective being to create the lightest model possible.
   - Points will be awarded as determined by weight.
   - The Rovers *will not* be weighed with the battery boxes and extended wires.

2. **Hill Climb Test (10 points):**
   The Rover will be tested on its ability to travel up an incline. The score received is 10% of the composite score, with the objective being to climb the highest incline possible.
   - The starting incline will be 20 degrees and will be raised incrementally to find the maximum incline which each Rover is able to successfully climb.
   - For competition purposes, each Rover should be able to climb a minimum slope of 30 degrees.
   - For each climb, a Rover must travel a total distance of 2 feet.
   - If a breakdown occurs, the Emergency Mechanic will be given ***ONE*** opportunity to repair the Rover. The Team may re-start the hill climb at the same incline where breakdown occurred.
   - No penalty will be assessed due to a breakdown during the hill climb test.

- The test is concluded when a Rover overturns or can no longer advance up the slope.
- Of the 10 points possible for the hill climb test, 2 points will automatically be awarded to each Team which successfully climbs the minimum slope of 20 degrees. The remaining points will be awarded according to the greatest incline the Rover successfully climbs.
- In awarding Special Recognitions for the Hill Climb in the event of a tie, Rover weight will serve as the tiebreaker.

3. **Mars Rover Display and Presentation (25 points):**
   Creating a display and presentation for the Mars Rover - The score received for the display and presentation is a combined 25% of the composite score.
   - A table will be provided for each Team's display. However, displays should all be "free standing"; displays will *not* necessarily be set-up with a wall behind them. Posters must be no more than 3' wide × 2 1/2' deep × 4' high maximum.
   - The entire Team must be present during the poster presentation.
   - The display may incorporate posters, photos, charts, illustrations, etc.
   - Computers, Video Equipment, TVs, etc. are **NOT** allowed to be used during the actual presentation at the contest. They may be used to design the presentation, but not used as a prop for the actual presentation.
   - Each Engineering Team should assign a single, knowledgeable Team member to serve as the Team's spokesperson for the display presentation. He or she should be able to convince the panel of judges that his or her Team's vehicle is the best constructed, most thoughtfully designed Rover available for the purported mission to Mars. However, it is highly encouraged to have the entire Team involved in the poster presentation in some fashion.
   - The presentation and display should focus on those areas being scored by the judges, especially the use of the engineering design process (see display and presentation scoring form, Scoring Forms section).
   - A total of 10 minutes will be allotted for the judging of each Team's display and presentation. *A maximum of 6 minutes* will be given for the designated presenter to highlight the display for the judges, and 3 minutes will be given for the judges to ask the presenter any questions and to further examine the display.
   - Considering the short time allotment, the Team should practice and time the presentation to be certain that it is less than 6 minutes in length. The Judge will notify the Presenter after 5 minutes have passed.

4. **Martian Rock Collection Test (15 points):**
   The Rover is to collect at least one of the five colored Martian "rock samples" on the Mars Test Course. The total number of samples that a Rover storage unit contains when time has expired will constitute 15% of the composite score, with the objective being to collect at least one sample of each color.
   - Rovers should be capable of climbing a slope of 30 degrees to navigate the Course. The rock samples will weigh similar to Mars rocks in a "near-zero" gravity environment, be constructed of a rough texture, and range between marble and golf-ball size.
   - The Rover must be able to collect the samples and store them as it completes the test.

- Only those rock samples which the Rover contains at the conclusion of the test will be counted in the rock collection score, and only ONE of the each-colored rock will count in the initial score (*2 red rocks will not count for extra points, for example*)
- The clock will *not* stop for any vehicle which overturns, becomes stuck, or has a minor breakdown during the rock collection test.
- An overturned Rover may be turned upright by the Rover Assistant without penalty but will be returned to its position prior to overturning.
- If a Rover becomes stuck or is unable to negotiate a given section of the course, the Rover Assistant will be allowed to advance the Rover one vehicle length in any direction. *One point will be deducted from a Team's composite score each time such an advancement is needed.*
- If a catastrophic breakdown occurs and major repairs are necessary, the Emergency Mechanic (see Rules and Regulations: Rover Testing) will be allowed to make repairs and the Team will have *one* opportunity to rerun the test after all other Teams have competed.
- If a Team must rerun the course due to a *major* catastrophic breakdown, the Team will be completely re-scored on the test (i.e., any penalty advancement points deducted, and any rocks collected during the initial test will *not* be considered).
- Each Team will be given 5 minutes, including penalty seconds, to collect and store as at least one rock sample of each color as possible. If time remains after this has occurred, a Team may collect additional rocks of any color or Marvin the Martian, for the possibility of a special recognition.
- Of the 15 points possible for the rock collection test, 5 points will automatically be awarded to each Team which successfully attempts to collect at least a single rock (aka rock is moved by pneumatic device) by the conclusion of the 5-minute test. The remaining points will be awarded dependent upon the total number of colored samples collected.
- In the event of a tie, the number of additional rocks collected, Marvin the Martian and the rover weight will serve as the tiebreaker.

5. **"Blind Driving" Teamwork Test (10 points):**
   The Rover driver will have eyes covered and will be "talked through" an 8-foot-long course containing several obstacles and turns. The score received is 10% of the composite score, the object being to traverse the course within the allotted time.
   - Rovers should be capable of climbing a possible slope of 30 degrees to navigate the Course.
   - Only the designated Rover Assistant will be permitted to provide the driver with instructions during the test.
   - The clock will *not* stop for any vehicle which overturns, becomes stuck, or has a minor breakdown during the running of the course.
   - An overturned Rover may be turned upright by the Rover Assistant without penalty but will be returned to its position prior to overturning.
   - If a Rover becomes stuck or is unable to negotiate a given section of the course, the Rover Assistant will be allowed to advance the Rover one vehicle length in any direction. *No points will be awarded for the missed obstacle each time that such an advancement is needed.*

- If a catastrophic breakdown occurs and major repairs are necessary, the Emergency Mechanic (see Rules and Regulations: Rover Testing) will be allowed to make repairs and the Team will have *one* opportunity to rerun the course after all other Teams have competed.
- If a Team must rerun the course due to a *major* catastrophic breakdown, the Team will be completely re-scored on the test (i.e., any penalty advancement points deducted during the initial test will *not* be considered).
- A 30-second time penalty will be assessed to any Team needing to rerun the course.
- A maximum of 5 minutes, including penalty seconds, will be allowed for each Team's "Blind Driving" test.
- Of the 10 points possible for the "Blind Driving" test, 2 points will automatically be awarded for each obstacle a Team successfully completes within the 5 minutes allotted. Best scores will be determined by the time needed to complete the course.
- In the event of a tie, the course time will serve as the tiebreaker. The second level of the tiebreaker will be Rover weight.

6. Rover Speed Test (10 points):

The Rover must navigate a route through the Mars Test Course. The amount of time that is required to go from the start to the finish will determine 10% of the composite score, with the objective being the fastest time possible.

- Rovers may need to climb a slope of 30 degrees to navigate the Course. There may be some areas which are steeper than 30 degrees which a Team may *choose* to traverse for shortcuts not accessible to those Rovers with lesser capabilities.
- The clock will *not* stop for any vehicle which overturns, becomes stuck, or has a minor breakdown during the running of the course.
- An overturned Rover may be turned upright by the Rover Assistant without penalty, but the Rover will be returned to its position prior to overturning.
- If a Rover becomes stuck or is unable to negotiate a given section of the course, the Rover Assistant will be allowed to advance the Rover one vehicle length in any direction. *One point will be deducted from a Team's composite score each time that such an advancement is needed.*
- If a catastrophic breakdown occurs and major repairs are necessary, the Emergency Mechanic (see Rules and Regulations: Rover Testing) will be allowed to make repairs and the Team will have *one* opportunity to rerun the course after all other Teams have competed.
- If a Team must re-navigate the course due to a *major* catastrophic breakdown, the Team will be completely re-scored on the test (i.e., any penalty advancement points deducted during the initial test will *not* be considered).
- A 30-second time penalty will be assessed to any Team needing to rerun the test.
- A maximum of 5 minutes, including penalty seconds, will be allowed for each Team's Rover speed test.
- Teams who do not complete the course in the allotted time will be ranked according to each Team's final distance from the finish line.
- Of the 10 points possible for the Rover speed test, 5 points will automatically be awarded to each Team which completes the course within the 5 minutes allotted. The remaining points will be awarded dependent upon the minutes and seconds required

to complete the speed test. Those unable to complete the course will be scored on a reduced scale according to the distance from the finish line.

- In the event of a tie for Fastest Rover Special Recognition, the completion time will serve as the tiebreaker. The second level of the tiebreaker will be Rover weight.

7. **Lab Notebook and Budget (20 points):**
   Each Team will be required to turn in its Lab Notebook at check-in. It will contain the signed Responsibility document, a Team timeline, Team checklist, day-to-day entries, individual pie charts, three budgets, a short paper about what was learned with effects on the design after their poster presentation and any activities completed by the Team during preparation.
   The Lab Notebook will be scored for completeness and clarity. The score received for the Lab Notebook and budget is 20% of the composite score.

The Lab Notebook

The Lab Notebook is referenced often in the Activity Books. What exactly is this Notebook? The Lab Notebook is a vital part of the Engineering Challenge because it allows each Team to document the entire Engineering Design Process. Other details of the Lab Notebook requirements are included in the Teacher Activity Book and Student Activity Book. Please use the following overview and suggested activities from the Activity Book to help your Team get started.

REMEMBER – The Lab Notebook is a **working** notebook, **NOT** a paper written at the end.

The Team **MUST** maintain a **Lab Notebook** of the design process and expenses. It must have **DATED** entries and must **OUTLINE** the work as the Team progresses through the Engineering Design Process. The Lab Notebook is a record of the work of the Team on the Rover, and must be handwritten, *not* typed. The budget pages must include both *actual* expenditures and *estimated* values of any materials used but not purchased. It may also contain drawings, brainstorming sessions, anything fun that happened at the meeting, and anything the Team learned.

Encourage your Team to select a 3-ring binder. Add blank sheets of paper for writing the entries as they work through the activity process. They may want to make a cover page with the School/Group Name (as registered) and the Team name. The first item in the binder should be the signed Responsibilities pages. We encourage Teams to include the contract created during the "Building a Working Team" activity. None of the Team-building activities are required to be included in the notebook, but it is highly encouraged that your Team include their notes if possible.

★ **Responsibilities**
All Team Members, the Coach, and any others assisting the Team must sign the Responsibilities pages. It is placed first in the Notebook.

Recommended Activity:
"3-2-1 Pop! – An Effervescent Race"

★ **Timeline**
The Timeline details when and in what order the Team will complete ALL components of the Engineering Challenge and the Engineering Design Process. **It should be the first entry in the Notebook,** after *Responsibilities*. The Suggested Timetable is for Coach use. Students must create their own original ***Timeline***.

★ **Team Checklist** from Competition Guide

★ **Daily Entries**
Daily Entries show each step of designing and constructing the Rover. These entries will also reflect the Engineering Design Process. The detailed entries are dated and hand-written by a Team Member to document the process.

Recommended Activity:
"Earthling Exploration of Mars"

★ **Budgets**
Three separate, itemized budgets must be included in the Lab Notebook to document the expenditures for (1) Additional Lego® parts ($75 maximum); (2) Use of Non-Lego® Allowable Elements; and (3) Display construction ($50 maximum).

★ **Pie Charts**
A pie chart for each Team member must be included in the Lab Notebook. Each pie chart should categorize that Team member's contributions to the design process.

★ **Summary** of Mars research and how it affected their design.

Summary of Competition

Team – Each Team **MUST** have a teacher sponsor who will be fully responsible for the Team, provided LEGO® kit, and be the main point of contact for the Team

- ✓ Each Team **MUST** have **4** students from 3rd through 5th grades for Elementary OR 6th through 8th grades for Middle School that attend school in the same school district
- ✓ Each Team may have up to **TWO** mentors (7-12th graders) to assist the Team
- ✓ Each Team may have an unlimited amount of parental and community support

Mission – The purpose of **Engineering Challenge** is to build a Mars Rover **AND** to present the Rover in seven different areas at the Engineering Challenge Competition.

- ✓ The Rover created **MUST** have a rock collection device, and a rock storage area
- ✓ A Lab Notebook **MUST** be kept during the entire **design and competition process** and **MUST** include a timeline, 3 itemized budgets, day-to-day notes, and individual pie charts
- ✓ A Team **MUST** do a verbal and poster presentation at the competition

Expenses – Each Team is responsible for the following expenses

- ✓ No more than $75 for additional LEGO®s (these are NOT provided by Academic Rodeo). Additional LEGO®s are purchased directly from the vendor by the Team). ***ANY TEAM WHO SPENDS MORE THAN $75 ON ADDITIONAL LEGO®S WILL BE AUTOMATICALLY DISQUALIFIED***
- ✓ No more than $50 for the poster display
- ✓ An unlimited fund base for "non-LEGO® Allowable Elements," including batteries, as described in this manual
- ✓ Replacement of components lost or damaged
- ✓ Funds for replacement of kit IF not returned as directed

Supplies – The provided kits, *including any instruction booklets*, are to be returned to Academic Rodeo within 4 weeks after the Awards Celebration and should be *in complete, working order - or charges will result.*

- ✓ You may only use the provided LEGO® kit, up to $75 in additional LEGO®s, and/or items on the "non-LEGO® Allowable Elements" list to construct the Rover
- ✓ You may have up to three battery boxes **– OR –** three motors as a part of your Rover design. The $75 additional LEGO® budget does **NOT** allow you to incorporate three battery box/motor/wire set-ups into your Rover design.
- ✓ Teams may **NOT** use geared-down motors, or any other power source other than the 9-volt simple motors and pneumatics provided to operate your Rover. The Rover **MUST** operate without the need to push or pull it manually. This includes the operation of your rock collection device