Cars4Mars
African Rover Challenge

Organizer Contact: basia@cars4mars.co.za

RULEBOOK

What is Cars4Mars - African Rover Challenge about?

The challenge is to design and build a Mars rover prototype. This is not expected to be a space-grade machine and does not need to be ready to operate in actual space or Mars conditions.

Instead, the rover prototype should be a small, mobile robot. It needs to be controlled wirelessly and have an independent power source (i.e. battery).

Who can compete?

This challenge is addressed to students. You need to compete as a team. All members of the team have to be students actively enrolled in high school, college or university programme during the entire duration of the competition.

Teams are encouraged to consult professors, experts or engineers (called Faculty Advisors) for advice and guidance. However they cannot be registered as part of the team and the engineering, design, manufacturing and operation of the rovers needs to be done by students.

Each team is required to have a single Team Leader (also needs to be a student). This person will be responsible for official contact with the Organizers and making sure that their team complies with the competition rules.

What is the Challenge?

The challenge is to design and build a Mars rover **prototype.** This is not expected to be a space-grade machine and does not need to be ready to operate in actual space or Mars conditions.

Instead, the rover prototype should be a small, mobile robot. It needs to be controlled wirelessly and have an independent power source (i.e. battery).

The challenge is divided into two stages.

Launch Stage
Launch Stage (1st stage) is held online. During this stage, students will design and build their robots at their homes, schools or universities. They will need to present their project strategy, design and, finally, the capabilities of their manufactured rover. They will also have the opportunity to showcase their knowledge of Mars geology and astrobiology.

All of this will be done by sending the judges written reports and a video of the rover.

This stage will have its own final, where teams will have the opportunity to meet online, hear interesting talks from guest speakers from the robotics and space industry and give their final presentations. The best teams of this stage and a full ranking will be officially published.

Mars Stage
Best teams from the Launch Stage (1st stage) will be invited to compete in the Mars Stage (2nd stage). This stage will allow the teams to meet face to face together with their rovers on a specially prepared obstacle course.

Students will need to operate their rovers wirelessly and complete a series of tasks on the special obstacle course. These tasks will be designed to resemble some real scenarios that could be expected from future rovers on the surface of Mars (e.g. exploring rocky terrain, transporting medicine to an astronaut in need). Top teams from this stage will be awarded.

This special event will provide students an opportunity to not only test their machines in real, thrilling scenarios, but also meet other people with similar passions and invited guests.

Competition Schedule

Stage	Event	Deadline
Launch Stage (teams design and build rovers in their own towns)	Team registration	29 Feb 2024
	Project Strategy Report	5 May 2024
	Final Design Report	11 Aug 2024
	Video	11 Aug 2024
	Qualification for the Launch Stage final	25 Aug 2024
	Launch Stage Final	14 Sep 2024
Mars Stage (teams drive their rovers together on one course)	Qualification for the Mars Stage	15 Sep 2024
	Mars Stage	26 Oct 2024

TBD = to be determined

Launch Stage

During this stage your team will develop a series of deliverables, that will be sent to judges online. Each of these deliverables is scored and counts towards the final ranking for the Launch Stage.

Timeline of the Launch Stage with deadlines for sending deliverables is presented below:

Event	Deadline
Team registration	29 Feb 2024
Project Strategy Report	5 May 2024
Final Design Report	11 Aug 2024
Video	11 Aug 2024
Launch Stage Final	14 Sep 2024

Each deliverable will be send online via a form that will be shared with registered teams. The only exception is the final deliverable - Launch Stage Presentation which will be held live online during a special event followed by a ceremony to award top teams.

These deliverables are described below.

Project Strategy Report

This is a written document presenting your team's strategy for a successful run in the challenge and your initial ideas for the rover design.

You should follow this template:
[Template Project Strategy Report]

It contains descriptions and tips from judges on what to include to get a good score.

You can use both text and graphics (images, diagrams, etc). Format requirements for this document are:

- max 6 pages A4
- font size 11 or more
- margins at least 2.54 cm (1 inch)

Final Design Report

Details TBD.

This document will allow students to showcase the final design of their constructions, decisions they made while developing the project and reasons for them.

Video

Record a 5 min video presenting your team and your rover. You should include the following elements in your video (each one is scored):

- Introduce team (mention school, university, city, country)
- Explain reasons you decided to participate in the challenge
- Present your rover working
    - Drive forward and backwards
    - Turn to avoid obstacles
    - Transporting 1kg object onboard
    - Drive on difficult terrain (rocks, hills, sand)
    - Control the rover wirelessly
    - Video from the rover cameras streamed wirelessly to operators

Most points will be awarded to teams that will show the best readiness and good design of their rover. For example, a rover that is driving and also streaming video, it will be scored higher than a rover that is only able to drive, but can not stream video. Showing your rover complete a difficult obstacle course or drive on more difficult terrain will also allow you to score extra points.

This report will require you to write a short essay on the topic of Mars science. Exact requirements will be published at a later stage.

Launch Stage Final

Details TBD.

This will be in the form of a live presentation that will be held online in front of judges and other teams. Exact requirements will be published at a later stage.

Generally speaking, you will be expected to present:

- Project management methodology
- Your final design
- Lessons you learned during the challenge
- Ideas for improving or commercializing your project
- Short topic on science of Mars

Mars Stage

General requirements

Physical requirements

Maximum rover dimensions are:

- 80 cm width

- 80 cm length
- 250 cm height (including any communication masts)

Maximum weight of the rover is 40 kg

.
These limits do not apply for any equipment inside the command station used for controlling the rover.

Rover needs to be a standalone platform, meaning it can not be attached via cables. It needs to have its own power source. Combustion engines are **not** allowed as a power source (such designs would not work on the surface of Mars). Teams are encouraged to use electrical batteries.

Command station

The rover should be controlled remotely by a human operator, or multiple operators, from your team. During the entire duration of any competition mission, the operators will need to stay in an enclosed space (tent or trailer provided by the organizers) called a command station. This space features **no** windows. Operators will not be able to see the rover or the course with their eyes. This means the rover needs to feature onboard cameras and the video will have to be sent live to the command station in order to operate the rover. In case your vision system fails to work, you can control the rover using eye sight, but this will result in a very heavy point penalty for that mission.

Before the start of the mission, your team will get 15 min to set up all necessary equipment inside the command station (like laptops, monitors, controllers etc.). Radio masts or other communications equipment can be set up max. 10 m from the command station.

After the mission begins, no one is allowed to enter the command station. A team member who would leave the command station can not get back inside it until the end of the current mission.

Any human communication between the operators and people outside the command station will be considered cheating and result in 0 points scored for that task. People inside the command station can only communicate with each other or with a judge who will be present inside the command station through the entire time of the mission.

Maximum distance that the rover needs to traverse from the command station can be max. 100 m.

Safety

All rovers need to feature an easily visible and easily accessible emergency stop button, that will immediately cut power to the robot. This is required to ensure that the rover can be stopped in case it poses danger to any human or equipment.

Interventions

During the competition mission no human can touch the rover (apart from safety interventions). If the rover breaks, the team can call an intervention. During an intervention team members can touch and repair the rover using any equipment they bring with them. Mission time does not pause during intervention.

Competition missions

The competition features 4 missions: 3 rover missions and a presentation mission. In the time between competition missions, teams can have access to the rovers to repair them or modify them as they see fit. Rovers configurations can be changed for different missions (but each configuration needs to be compliant with the competition requirements).

Offroad Mission

Time limit: 15 min for preparation + 20 min for traversal.

Your rover will need to traverse through demanding terrain filled with obstacles. Obstacles can include hills, rocks, craters, bumps, sand and others. Some obstacles can be passed by, others will have to be taken heads on. The more obstacles your rover is able to overcome during mission time, the more points you will get.

Astronaut Support Mission

Time limit: 15 min for preparation + 30 min for traversal.

Your rover will need to help astronauts carry out some tasks that are part of everyday life at the Mars colony. These can include:

- Use the rover to find objects hidden in a demanding terrain (e.g. a hammer,
- screwdriver or wounded astronaut). Extra points will be awarded if the rover can take pictures of these objects.
- Use the rover to transport an object from one astronaut to the other (e.g. a box of medicine). The object will be max 0.5kg and 20x20x20 cm. The rover should have a storage unit, where this object can be safely stored while traversing rough terrain. Rovers do **not** need to have a robotic arm - the object will be picked up by an astronaut.

- Use the rover to read signs left by an astronaut.

Science Mission

Time limit: 15 min for preparation + 20 min for traversal + 10 min for discussion

Your rover will need to conduct research about the geology of the region. This can include:

- Use the image from the rover to recognize some minerals, rocks or geological formations.
- Use the rover to search for signs of water in the area.
- Take photos of objects of interest.

Immediately after your traversal ends, you will get a chance to present your findings to the judges. You can score extra points for providing scientific interpretations of your findings. Knowledge of geology, planetology or astrobiology will be scored.

Mars Stage Presentation

Details TBD

During the scored presentation you will get a chance to present your final rover design, your tactics for each of the competition missions and lessons learned along the way.