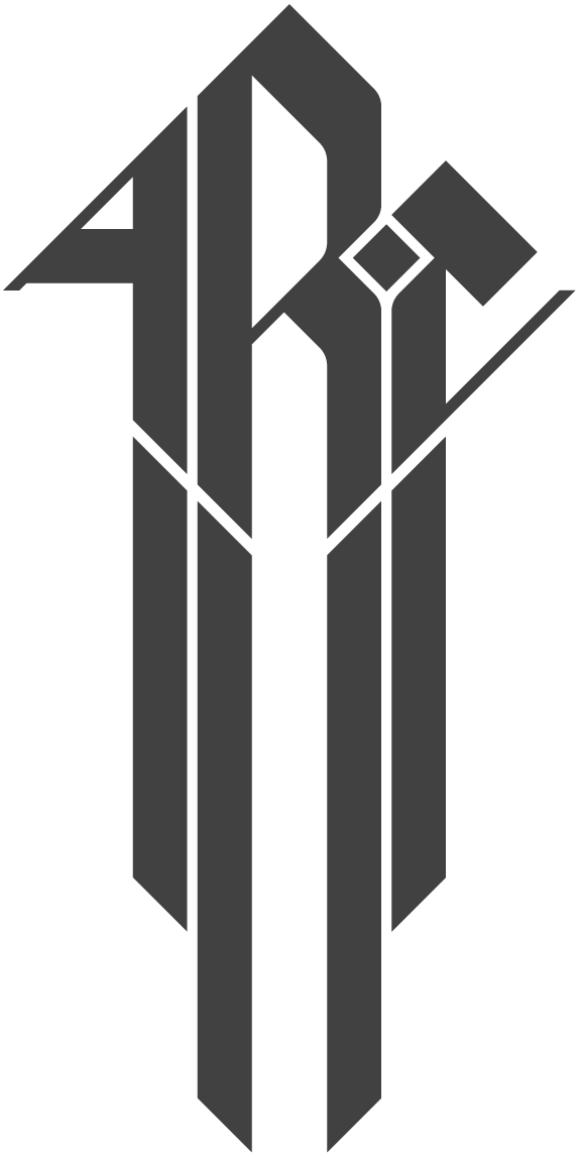

Anatolian Rover Challenge

2023 Manual

Version Information

This file is the ARC Manual v.3 released on 01.03.2023.
Written by the ARC Committee. Digitally distributed.

Changelog

ARC'23 Manual v.1 is the first released version of the ARC’23.
ARC'23 Manual v.2 is the second released version of the ARC’23.
ARC'23 Manual v.3 is the final version of the ARC’23.

Information Channels and Contacts

The Anatolian Rover Challenge website is the main source of information about the event.
The ARC Website: www.anatolianrover.space
The ARC Mail Address: contact@anatolianrover.space
Contact persons:

1. **Bahadır Onur Güdürü & Nurdeniz Altuntaş**
   ARC Co-General Managers

2. **Işık Su Yazıcı**
   ARC Rules Manager & Head Judge

3. **Inji Maharli**
   ARC Rules Assistant Manager

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1. Introduction

Anatolian Rover Challenge is an annual international **rover** challenge. In the scope of the challenge, the **teams** of students that are affiliated by academic institutions try to achieve the determined missions by their own designed "planetary exploration robots" called **rovers.** The student **teams** to apply for the challenge go through a **design report** process. After the evaluation of all reports, **teams** that qualify for the **finals** are determined and announced to participate in the **finals**. The **finals** are held in the carefully designed **challenge area**. The **challenge area** consists of an open field with a diameter of approximately 40 meters. The area is designed to resemble the surface of a planet or a celestial body to be explored.

During the **finals**, the **teams** perform the missions in a planned order. There are four different mission scenarios and many sub-tasks to complete for each mission. The scores received from the missions are determined by the **judges** based on the ARC Manual. On the last day, prizes will be given to the winning **teams**.

The ARC event aims to create an opportunity for **teams** to show their abilities in solving difficult engineering and scientific problems. **Teams** should design, manufacture and equip their **rovers** with the necessary abilities to complete all missions.

2. General Information

Anatolian Rover Challenge (ARC) 2023 will be held between 19-23 July 2023 in Ankara, the capital of Türkiye, in honor of the 100th year of the Republic of Türkiye. The challenge is organized by the **ARC Organizing Committee** (or the **ARC Committee**) which is a subcommittee of the **Space Exploration Society (UKET)** established to contribute to space studies in Turkey.

2.1. Participation Conditions

1. The application for the challenge is required to be submitted electronically using the online application system in the https://www.anatolianrover.space/apply-challenge address.
2. It is obligatory to participate in the challenge as a **team**, individual applications will not be accepted.
3. In case of any changes in the information given in the application, the **teams** must notify the **Organizing Committee**.
4. Each **team** is required to have a **Team Leader** and an **Advisor**, whose descriptions are given in the General Information section.
5. The deadlines for the reports and events are specified in the challenge calendar. The **Organizing Committee** reserves the right to change the calendar.
6. Only the **team** members must be the authors of all the required documents that will be submitted.
7. **An academic advisor** is required for all **teams**. The **teams** may have more than one **academic advisor**.
8. There can be more than one **team** from a single institute.

2.2. Calendar

2.2.1. Milestones

An up-to-date calendar of the challenge and important dates are shown in the table below. It should be kept in mind that the versions of the ARC Manual will slightly differ with regard to a few additional details. The missions will remain intact.

Date	Event
12.12.2022	Release of the ARC'23 Manual v.1
15.01.2023	Release of the ARC'23 Manual v.2
01.03.2023	Release of the ARC'23 Manual v.3
08.03.2023	Start of the Application Submission

Date	Event
08.03.2023	Start of the Design & Video Report, Science Report, and Cost Report Submission
08.04.2023	Early Application Due Date
03.05.2023	Late Application Due Date
03.05.2023	Design & Video Report, Science Report, and Cost Report Submission Due Date
28.05.2023	Announcement of the Finalists
19.07.2023	Challenge Registrations and Orientation
20.07.2023	Challenge Day 1
21.07.2023	Challenge Day 2
22.07.2023	Challenge Day 3
23.07.2023	Challenge to Shine, Side Missions and Awards Ceremony

2.2.2. Details

1. The deadline for applications is the same as the **Report** submission due. After this date, applications will be invalid and will not be considered. **Teams** that apply early may be given priority in the challenge day timetable.
2. Registration for the **finals** will be performed on-site on the stated dates.
3. On the closing day, the **teams**' total scores will be calculated and announced, and awards will be given to the top **teams**.
4. The first version of the timetable including the exact time slots for each mission will be announced by the **Organizing Committee** one week prior to the event, while the final version will be announced on the first day of the challenge.

- Each **team** is responsible for complying with this timetable. **The Supreme Board of Judges** reserves the right to reject any request for change in the challenge day timeline.

5. All finalist **teams** must attend the registration day to get their name tags. Otherwise, they would not be officially registered as finalists.

2.3. Emergency Handling

Necessary precautions and disaster plans have been made for the safety of the **teams** and the **challenge area**. **Teams** are expected to comply with the safety instructions from the **ARC committee** on site.

In case of any injuries, first aid will be made by paramedics and if necessary, the injured person will be sent to the nearest hospital by an ambulance. By applying for the ARC, **teams** will be considered as accepting the necessary emergency actions by the **ARC committee**.

2.4. Challenge Fee

The early submission fee is 20 US Dollars, which should be paid by 08.04.2023. For the applicants who submit their fee after this date until the last day of submission of applications, the late submission fee is applied which is 50 US Dollars.

Teams that qualify for the finals must send the challenge fee of 200 US Dollars after the announcement of the finalist **teams**. The payment details will be specified on the website.

2.5. Questions and Answers

The **Organizing Committee** will provide '**Anatolian Rover Challenge 2023 Questions and Answers**' as a part of the challenge rules. The **teams** are encouraged to ask questions through this section, keeping up with the updated Q&A section is recommended. The Q&A section overrides ARC Manual.

2.6. Change in Rules and Delivery Dates

The **Organizing Committee** reserves the right to extend the deadline for document submissions and make necessary but unavoidable corrections to the challenge regulations at any time. All changes will be announced in advance on the challenge website. **Teams** are obliged to follow these changes on the challenge website. Major changes in rules are stated through the versions of the manual:

- 15.01.2023 – the ARC Manual Version 2 (v.2)
- 01.03.2023 – the ARC Manual Version 3 (v.3)

2.7. Finalists

The finalist **teams** will be selected by the **judges** and the organizer based on the reports submitted by the **teams**. The finalists will be announced on the date specified in the schedule.

3. General Rules

The general rules are listed below:

1. All the **teams** present in the on-site challenge will be given a certificate of participation.
2. Rewards will be given according to the ranking of the scores collected from missions.
3. The **academic advisor's** job is to help students plan their projects, guide them academically, and support them mentally and emotionally. The awards to be given at the end of the challenge are only for the **team members**.
4. The **teams** are obliged to show the expected care for their surroundings and other **teams** while competing.
5. "Safety Specification" will be read and signed by each **team member** before the challenge.
6. All **team member**s are obliged to comply with the rules specified in this specification. If non-compliance is determined by the **Organizing Committee**, the relevant situation will be brought to the attention of the **Supreme Board of Judges**. As a result of the evaluation of the **Supreme Board of Judges**, individuals or **teams** may be disqualified from the challenge.
7. During the entire event, no **rover** or any part of the system of the **rover** may damage or interfere with other **teams**' systems. Any reports of such violations will be investigated independently by the **judges** or organizers, and any violation of this rule may result in the **team**'s disqualification from the challenge. The **Organizing Committee** will not be held responsible for any of the damage caused to **teams**' systems.
8. **Teams** and members are fully responsible for any damage, accident, situations, events, etc. caused by hardware-software. All the precautions and rules declared by the **Organizing Committee** must be strictly followed. Any violation of safety regulations and standards will result in the disqualification of the **team** from the challenge.
9. The use of any **Prohibited Substance** during the challenge is prohibited and constitutes a crime under the laws of our country. Persons/**teams** who use and disturb the environment will be disqualified from the challenge.
10. In case of a dispute regarding the challenge, the decision of the **Supreme Board of Judges** will be considered binding.
11. In case of violation or cheating of the rules or specifications, action will be taken.
12. **Teams** must comply with the directions and instructions of the **Judges**/**Organizing Committee**.

3.1. Rover Design Requirements

In order to participate in the challenge, the general requirements specified in this file must be met. **Teams** have to indicate in their technical reports that they meet these requirements. In exceptional cases where **teams** are unable to meet the general requirements, they should contact the ARC **Organizing Committee** before submitting the technical report. In the case of any violation in requirements, the organizer has the right to remove the **team** from the challenge.

3.1.1. Weight Limitation

The weight limitation applies only to the **rovers** and does not include fixed antennas, computers, and other equipment. The **rover** will be weighed at the start of each mission.

1. The **rover**'s weight which is ready to start the mission should not be more than 60 kilograms.
2. **Rover**s over 60 kilograms will receive 5% penalty points for each kilogram weighing more than 60 kilograms.
3. The total weight of the **rover** and installed mission specific hardware in all missions combined must not exceed 80 kilograms.

3.1.2. Size Limitation

The size limitation applies only to the **rovers** and does not include fixed antennas, computers, and other equipment. Without any outside **intervention**, the **rover** can exceed the size limitation during the mission and finish the mission above the size. The missions of the challenge are designed for a 1.5m x 1.5m x 1.5m vehicle, the large-scale **rovers** might not pass the expected passages in the missions, and might not complete the missions.

3.1.3. Cost Limitation

Total cost of the **rover** systems cannot exceed 20000 US Dollars (see Cost Report).

3.1.4. Design Advice

Rover should be designed by considering the climate and environmental conditions of the region where the challenge is held. Any damage that may arise from environmental conditions is the responsibility of the relevant **team**. During the missions, **rovers** will work in the open field, and the challenge plan may be rescheduled in very windy, rainy, or foggy weather conditions. It is the **teams**' responsibility to design or maintain their vehicles and equipment in such a way that they will not be affected by environmental conditions, during or before the challenge. Organizers are not responsible for any damage that may occur in the event of unsuitable environmental conditions.

The challenge grounds will be prepared through the inspiration of the surfaces of the planets on which the scenarios take place. It is recommended that **rovers** designed to perform the missions given in ground conditions such as gravel, either loose or hardened soil, fine particle sand. Also, **teams** should keep in mind that there will be craters and slopes which may cause a challenging drive of the **rovers** in the field.

Standard European type 220-230 V 50 Hz AC F type socket will be provided to the **teams** at the **bases**. In addition, facilities such as tables, chairs and extension cables will be provided at the **base**. In this regard, the organizers can make additions according to the recommendations from the relevant **teams**.

3.1.5. Rover Safety

3.1.5.1. Activity Light

Rover should be to show its operational status with a lamp. The lamp should have green and yellow colors. The green light should be on when remotely controlled, and the yellow light should be on during the autonomous control. While there are no technical restrictions on lamp power and location, reasonable approaches should be expected from **teams**.

3.1.5.2. Emergency

Rovers must not cause electrical, thermal, or mechanical harm to people who might want to stop it or to the people around them. The **field crew** of a relevant **team** is responsible for this. **Teams** are liable for damage caused by their **rovers** and activities while on and off the mission.

1. A red emergency button with a diameter of at least 3 cm should be available on the **rover,** and this button should be kept in a visible place. Otherwise, the **teams** will not be allowed to start the mission. The emergency button must stop the transmission of power to all the **rover**'s moving systems and disconnect all batteries. Note that the emergency button will be effective in the evaluation process.
2. There is no limitation on the **rover**'s cruising speed. Apart from the mission, the relevant **teams** must control their **rovers**, taking into account the safety of the living creatures in the **challenge area.**

3.1.5.3. Use of Flammables-Explosives

When **teams** want to use pyrotechnic systems, they must contact the **judge** before the challenge and provide the associated MSDS documents.

3.1.6. Communication Equipment Usage

Teams can communicate between the **rover** and the **base** using a radio link. It is necessary for the success of the challenge missions that the communication systems of the **teams** cover the **challenge area.**

In the **challenge area**, **teams** will set up their equipment in the **base**. They can place the antenna outside so that their communication equipment is next to the **base**. **Teams** will be settled in the **bases**, so the need is at least 10 meters of cable for their communication antennas. **Teams** will be

shown a certain area near the **base** to put their antennas. Antenna masts cannot exceed 3 meters in height and the area might not be supportive for thin legged masts as it is composed of loose soil.

During the challenge, **teams** are free to choose communication bands and equipment. For this reason, planning should be done considering the field can be approximately 40 meters in diameter. It is recommended that the communication equipment can work in the same environment as the surrounding wireless devices.

During the challenge, the equipment can be used by the law numbered 5809 of the constitution of the Republic of Türkiye. For the frequency bands available for use, the table below is recommended to be examined.

https://www.btk.gov.tr/uploads/undefined/mfp-01-02-2019.pdf

It is the **team**'s responsibility to operate the communication systems within the legal power and frequency limits.

3.2. Penalty Conditions

People or **teams** that do not comply with the conditions specified in the General Rules and Ethical Rules will be evaluated by the **Supreme Board of Judges**. If deemed necessary, individuals or **teams** are asked to defend themselves. As a result of the evaluation, penalties such as deduction of points, failure of the mission, or disqualification from the challenge may be given. The **Supreme Board of Judges** has rights to erase up to all points of the **team**. The result of the evaluation is announced until the last day of the challenge.

3.3. Objection Process

1. The pre-challenge objection process works as follows:
    a. Before the challenge, objections regarding the challenge venue or the rules must be made to the **Organizing Committee** via the website specified in writing.
    b. Objections regarding the evaluation process of the reports must be made in writing to the **Organizing Committee** via the email specified.
    c. These objections will be submitted to the **Supreme Board of Judges** by the **Organizing Committee**, and the necessary examinations will be made by the **Supreme Board of Judges**.
2. During the challenge, the objection process works as follows:
    a. **Teams** are allowed to object to the decisions taken by the **judges**, for review by the **Supreme Board of Judges** consisting of all **judges**.
    b. Video recordings taken by the **Organizer** during the challenge preparation and mission are used as evidence for objections.
    c. Each **team** has a maximum of 3 objection rights.
    d. All objections made are evaluated at the end of the day.
    e. Objections are made in writing by the **team leader** through the objection form on the website. Information is given about the causing event for

objection, and the objection is justified in a way that does not exceed one paragraph.

f. The **Supreme Board of Judges** will announce the results of the objection evaluation at the latest before the challenge award ceremony.

g. Any questions during the challenge will be addressed by the relevant **judge**. **Teams** can not object to a third person.

3.4. Ethics

1. Any kind of inappropriate behavior will be noted by The **Organizing Committee** and related authorities will also be informed immediately if necessary.

. These behaviors can be summarized as follows;

   a. Insulting, swearing, threatening, etc. actions against other **teams**, people, or organizations through social media or in the **challenge area** during the challenge period.

   b. Physical, verbal provocation, etc. movements towards other competitors during the challenge.

   c. Behaviors that may disturb other **teams** in and around the **challenge area**.

   d. Being involved in fights in the **challenge area**.

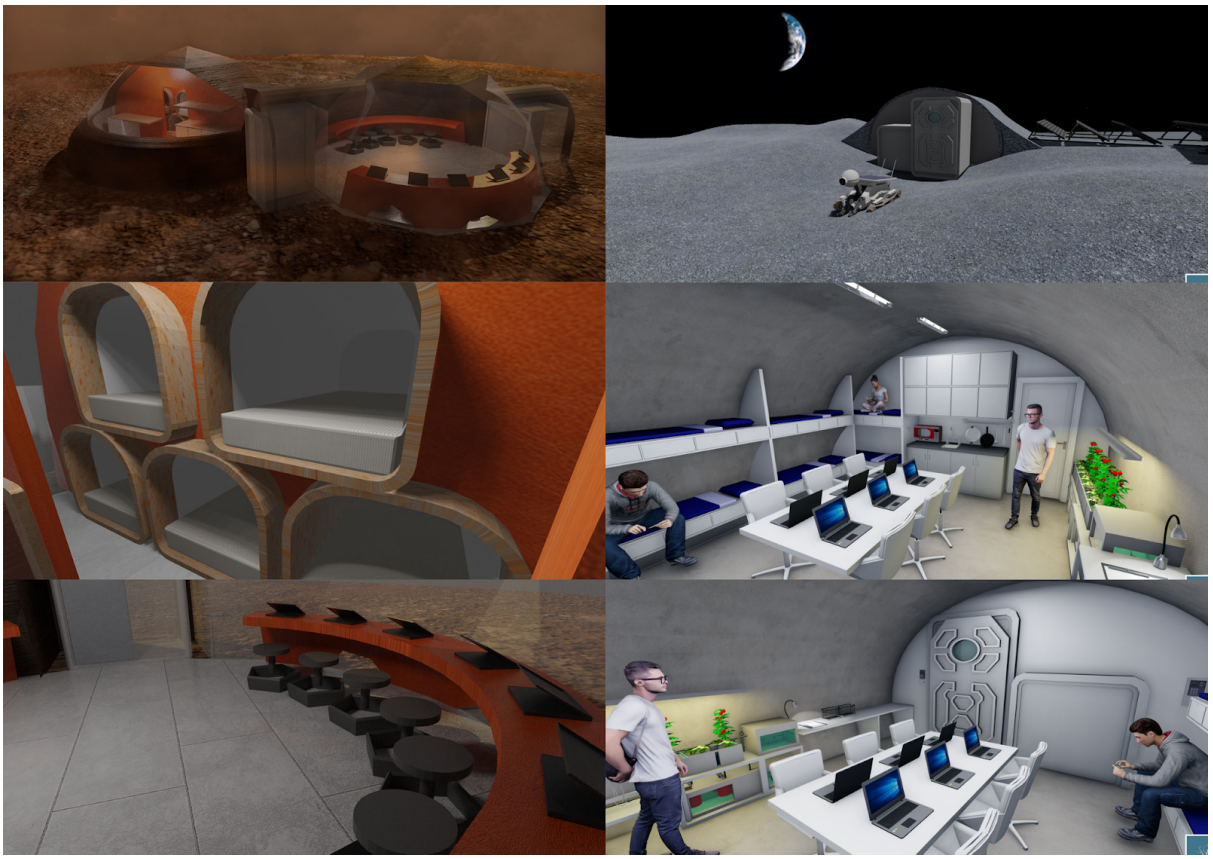
2. Language, religion, belief, political opinion, race, age, and gender discrimination will not be tolerated in the **challenge area**, as well as behaviors and practices that may jeopardize equal opportunity.

4. Definitions

Advisor: The person with an academic title that guides the **team**.

Airlock: The room connecting the **Base** with the Mars/Moon environment.

Bases: There are two **base** replicas in the **challenge area**, one on each **mission field**. **Bases** will be used as exhibition spaces within the competition area. Competing **teams** will control their **rover** within the **bases** during the missions.



They are closed areas that are located right in the **mission field** and connected to the rest only by an "**airlock**". Weight and size checks are made in the **airlock** as the **rovers** begin their mission. Only the **base crew** of the relevant **team** and the **judges** can enter the **base**. The **base crew** can only control the **rover** remotely (via remote-wireless connection). During missions, the **base crew** will not be able to see the **rover** directly. The relevant **team** must install the necessary equipment and antenna connections to the **base** to control the **rover** before starting the mission. Before each mission, **teams** will be given 15 minutes for Mission 1 to 3, and 10 minutes for Mission 4 excluding mission time, for this preparation.

Base Crew: It is a crew, formed by selecting among the **team members**, that is the only authorized and responsible crew to remotely control the **rover** in the **base**. The **base** team cannot communicate with the outside except the **rover** and **judges** during the mission. The **base crew** starts

and finishes commanding the **rover** by the **judges'** directions to accomplish the mission. During the autonomous driving stages, the **base crew** must comply with the instructions specified in the "**Rover Automation**" section and the directions of the **judges**. If **base crew** members leave the **base** when necessary, they cannot return to the **base** before the current mission is finished. That **team member** can only be a **field crew** or a spectator. The **base crew** may decide not to continue the mission. Until the decision is taken, they are considered to have completed the mission without losing their scores.

Border Violation: If the **rover** goes off-site, the **intervention** rules apply and the **field crew** brings the **rover** back into the field.

Challenge Area: The challenge takes place in two separate fields: **Moon Field** and **Mars Field**. The Mars Story Field is home to Mission 1 and Mission 4, while the Moon Story Field is home to Mission 2 and Mission 3.

Coordinate System: WGS-84 coordinate system and (Lat: dd.dd., Long: dd.dd.) format will be used when locations are given or requested. Ex: (41.100276, 29.020975).

Criteria for "Reaching Target": Measurements will be used to score points in mission steps that include expressions such as "goes/returns near the target". The distance between the outer surface of the target object and the **rover's** closest point to this surface is measured, if it is less than the asked distance (this distance is 2 meters unless otherwise stated), the **rover** is considered to approach or arrive. For example, to go near/**reach** the **base**, it is accepted that there is a part of the **rover** within 2 meters from the outer surface of the **base**. Mission descriptions can specify a length to use with these criteria.

Design/Science Report: See section 5.2. Reports for descriptions of the **Design Report** and **Science report**.

Designated Area: The landing site decided by the **teams** in the **science report**.

Field Crew: It is a crew consisting of a maximum of 4 selected members of the relevant **team** who can observe the **rover** in the **field** of mission, during the missions. The crew is responsible for the preparation of the **rover** in the **field** of mission, decisions on whether to intervene when necessary, and responding to the **rover** in emergencies. The **field crew** should not voluntarily enter the camera view of the **rover** during the mission. In the case of doing that by mistake, they should standstill. It is forbidden for the **field crew** to make hand signals or speak during their mission, except in emergencies and **interventions**. **Judges** may dismiss the **field crew** from the field of mission if any prohibited act is suspected.

Field Dimensions: Mars Field and **Moon Field** are approximately 40 meters in diameter, both sites have a circle shape. Coordinates of the center point of the fields will be elaborated in the Final Refinement document.

Finals: The on-stage challenges (explained in the Missions section in detail) that are held in Ankara, Türkiye. Only teams that are qualified and announced as finalists can participate in the **finals**. **Teams** that are not eligible for the **finals** or curious are encouraged to experience the challenge as observer teams.

Intervention: During the mission process, the crew or one **member** of the **field crew** may decide to intervene. They are required to notify the **judge** of these decisions before implementing any change. In cases where the safety of the living things in the field is at risk, as a result of a malfunction in the **rover** or the conscious control of the **base crew**, the **judges** may decide to intervene by pressing the **rover**'s emergency button. Mission time will not be paused when **intervention** begins. During the **intervention** on the **rover**, there is no limitation for the number of **team members** on the **field**. When the **intervention** is over, the general **field crew** rules are applied. The remaining **team members** should join the spectators. Only the **field crew** and **judges** can approach the **rover,** and the communication between the **base crew** and the **field crew** is made only one way through the **judges**. For each **intervention**, scores are deducted from the relevant **team** for that mission, as indicated in the scoring table. During a mission, the **rover** can be interfered with at most 3 times. When the 4th **intervention** is performed, it is assumed that the **team** has decided not to continue the mission. During the **intervention**, changes that will critically affect the **rover**'s functionality or relocation of the **rover** in such a way as to gain an unfair advantage in mission steps may be rejected by the **judge's** decision. All interferences which are in the **airlock** will not be considered as an **intervention.**

Judges: The **judges** are the most authorized officials in the challenge. It is essential to pay attention to and follow the instructions and directions of the **judges**. During the challenge, there will be at least one **judge** at each of the places like the **base**, the **field**, and around the **challenge area**. The **judges** are responsible for the organization of the challenge and guiding/assisting the relevant **team**.

Mission Fields: The areas where the missions will be performed in the **challenge area** will be referred to as the "**mission field**". During the challenge period, only the **field crew** of the relevant **team**, the **rover** of the relevant **team**, and the **judges** can enter the **mission fields** and interfere with the field and the **rover**. Illuminated indicators will be placed on the panels that are expected to be manipulated by the **rover** in the **mission fields**. The reason to do that is to control the completion of the steps and to facilitate the **base crew** to receive feedback with the camera image. **Mission fields** will be overhauled for the next relevant **team** by the **judges** at the end of each mission. **Judges** can make changes to the field to ensure equality while preparing the field.

There are two **mission fields**:

Mars field: Includes **Mars Base** and resembles Mars surface by its color and features.

Moon field: Includes **Moon Base** and resembles Moon surface by its color and features.

Organizing Committee/Organizer/The ARC Committee: The ARC Organizing Committee is a subcommittee of the Space Exploration Society (UKET). It is the committee that conducts and manages all the organizational processes of the **Anatolian Rover Challenge**.

Prohibited Substance: Substances that affect self-control, **team members** and the **rovers**, such as alcohol, drugs, all kinds of weapons etc.

Rover: Rover is a mobile device that can operate alone, without any power connection with another system, and can be composed of various subsystems. **Rover** can only be commanded from the **base** or can move on its own (autonomous). There can be cable and similar connections between

the subsystems and the **rover**. **Rover** can use these subsystems to perform missions in the **challenge area**.

Rover Automation: It is possible to perform certain mission steps autonomously. By performing these mission steps, **teams** can stand out with their **rover**'s autonomy abilities. For a mission step to be considered autonomous, the **base crew** must inform the **judge** that they will make this step autonomous before starting the relevant mission step. If information is not given to the **judges** before the next mission step, the **team** can not get bonus scores. **Teams** should not move their vehicle after they finish the mission step prior to the upcoming step that will be done autonomously. The last move that the **rover** does, must not contribute to the upcoming step. If a **team** violates this rule, their next mission step will not be considered autonomous, thus they can not get bonus scores.

The **teams** should not arrange the position of the **rover** to get an advantage for the autonomous movement. If such an arrangement is detected by the **judges**, the **judges** have the right to not give scores for this attempt. After the **team** submits the request to do the next mission step autonomously to the **judge**, they must switch their vehicles to autonomous activity mode and move a reasonable distance away from the control equipment. The **rover** should terminate the autonomous mode and automatically switch to the remote control mode after the completion of the autonomous mission step. The autonomous activity can only be attempted once for each mission step.

Skipping: Teams can skip the steps they want by informing the **judge**. They are not penalized by time or scores for the steps they skip; in case of **skipping**, mission time will not be paused. If a **team** does not use their right to skip, they must take each mission step in order, without **skipping**. In case of a skip, the **judge** can make the necessary changes on the **field** so that the next mission steps are not adversely affected. While the **judge** makes the necessary changes, it is forbidden to touch or intervene in the vehicle by any **team member**, and it is going to be considered **intervention** unless specified in the rules.

Supreme Board of Judges: The responsible committee for the examination and scoring of the reports and missions throughout the challenge, which is established on transparent principles, with international participation.

Team: A group of students that are affiliated with an academic institution and applied for the challenge. Each **team** must consist of at least two members and an **academic advisor**.

Team Leader: The responsible person for matters related to the **team** and the **rover**.

Team Member: A **team member** must be over the age of 18 and a university student of all levels. Members can take part in only one **team**.

5. Documentation

5.1. Application Form

Every **team** must complete the challenge application form on the official ARC website. **Team**s must provide **team** information that includes "**team** name", "list of the **team member**s'', and "the contact information of the **team leader** and the **team advisor**" to the **Organizing Committee**. **Team**s that do not present the complete **team** information before the **design report** submission is due, will not be allowed to participate in the challenge. After the application is completed, all **teams** must be on the discord server sent to them. During the competition, all communication will be made on the discord server. If any objection to this system exists, it will be considered.

5.2. Reports

5.2.1. Design Report

To become a finalist and participate in the challenge, the candidate **teams** must report their work and electronically send the report together with the video they prepared, as specified on the challenge website, within the dates specified in the challenge calendar. The **Design Report** will be uploaded for public view after the finalists are announced. The report must be prepared using the given template on the ARC website. Expected contents and scoring parameters are stated in the Score Tables section. This score combined with the video presentation score to be used for ranking the **teams** to select finalists.

5.2.2. Science Report

The **Mars field** is inspired by the Oxia Planum (18.275°N 335.368°E) and additional geomorphology: lava tube. From the given Mars coordinate, a scientific question should be determined to be investigated. This hypothesis should be explained in the **science report**. To test the hypothesis, a landing point on the given **challenge area** sketch should be specified. This landing point is the position where the relevant **team**'s **rover** will start Mission 1 during the challenge. While determining this starting point, two essential points should be considered. The landing point should be coherent with the scientific hypothesis as well as it should be a suitable terrain for the **rover** to drive.

The **Mars field** sketch made from the given coordinates is shown in Mission 1 section. It should be noted that the maximum depth or height of the structures in the area can reach 2 meters, and the angle between the structures and the ground level can be 30 degrees.

The report should also include which experiments were selected to check the scientific hypothesis that was determined. These experiments should be important in terms of checking the scientific hypothesis. Randomized experiments that do not contribute to the scientific hypothesis will not yield scores.

In this report, **teams** should indicate which scientific hypothesis they will test at the **designated area**, what kind of sample they aim to collect, what experiments they plan to perform on the sample, and what they plan to find as a result of these experiments. The hypothesis planned in

the **science report** should be taken into account during the challenge. The points of Mission 1 will be affected by the **Science Report**. Following a different hypothesis than the one stated in this report during the challenge will result in a score break.

5.2.3. Cost Report

Teams are obliged to write a report on the cost of their **rover**. The total cost of the **rovers** cannot exceed 20000 US Dollars. The cost report template has been shared with **teams** on our website. All the details on the template should be fulfilled by the **teams**, and there should be at least 30 expense items of the **rover**. All the provided information must be provable with official documents on the challenge day. The financial report is mandatory to participate in the final stage of the competition. In addition, the reports will be scored and the **team** with the best report will be awarded.

5.3. Video Presentation

Participating **teams** should prepare a video in which they show their **rover**'s readiness for the challenge. The video link must be uploaded to the website of the challenge together with the report, at the latest on the report submission date. The video must be shared by the participating **team** on a constantly accessible service (YouTube is recommended) without any access restrictions. The purpose of the video is to show the **team** and the **rover**'s compliance with the challenge regulations and how ready they are to obtain scores from the missions. The uploaded videos will be scored by the **judges** according to the criteria stated below. The video will be scored by the first 10 minutes. The suggestion of the **ARC Organization Committee** for the content duration is 6 minutes. Recommended content in the video and scoring is stated in the Score Tables section.

6. Background of the Missions

6.1. Mars Story

Mars, January 2023… Scientists have discovered a geomorphological structure that they believe to be a lava tube which has formed recently. In response, they quickly launched a mission to explore the area, sending 3 astronauts and a **rover** to the ExoMars landing site, the closest location to the unidentified structure with previous experience.

Upon arriving at the site, the astronauts set up a base and then sent the **rover** to explore the area for any changes on the surface. While one astronaut stayed at the base, the other two headed towards the unidentified structure, which they quickly identified as a lava tube. They sent their coordinates back to the base and reported that they were planning to get closer and even enter the lava tube. However, after their last communication, the astronaut at the base lost contact with them and decided to use the **rover** to search for them.

6.2. Moon Story

Moon, June 2023… A recent meteor shower threatens the settlement of the astronauts on the natural satellite of our beloved Earth. The inspection **rover** checks the power, communication and telescope units. As the **rover** checks the side, it detects damage to key structures. Astronauts are trapped because of the increase in radiation rates due to solar storms, a direct **intervention** is needed. Otherwise, catastrophe is inevitable. They have one shot, one opportunity to survive; a **rover** must be the beacon of light. For trapped astronauts to live, use the **rover** to perform various tasks to fix certain malfunctions. Fix the power and communication units, and adjust the telescope. Save the day! May the stars brighten your way as you turn into a symbol of hope for the victims of the dark side of the Moon.

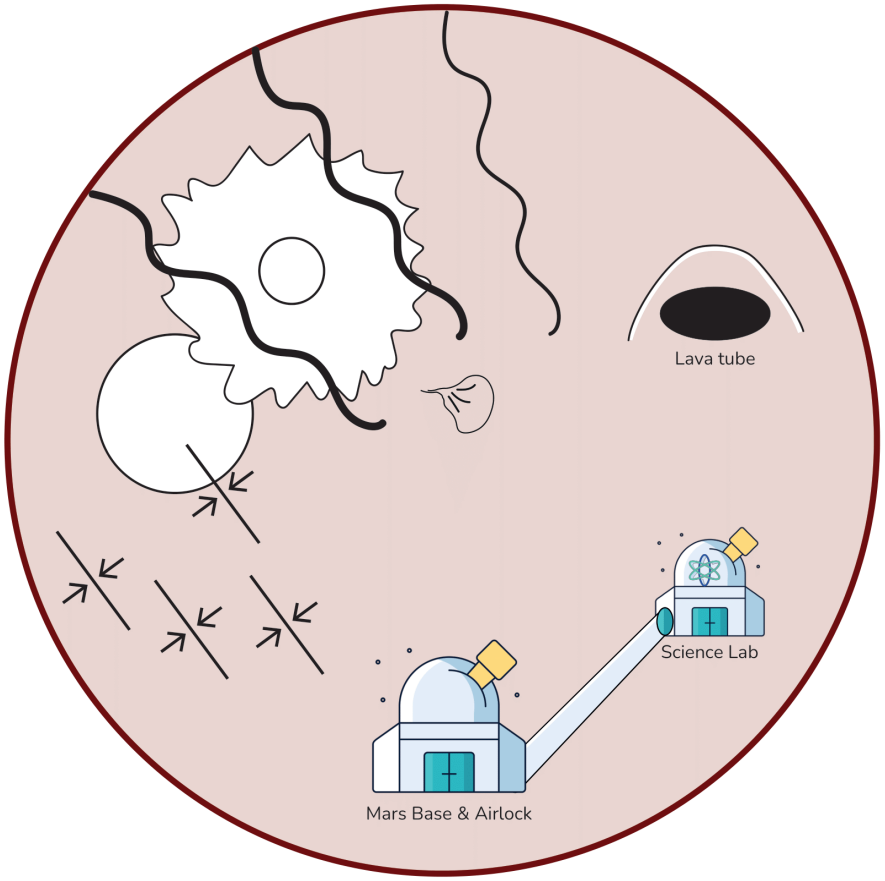
7. Missions

7.1. The Final Stage Missions

7.1.1. Mission 1: Science!

Time Limit: 60 min

Mission Field: Mars Field



7.1.1.1. Mission Steps

This mission is consisted of 3 main parts:

Part 1 | Landing & Field Excursion (30 min)

1. The mission starts from the **designated area**.
2. The area is surveyed, and the soil samples are collected.

During the sample collection process,

- panoramic photographs of the area
- photographs of the sampling site
- any additional measurements should be taken.

3. The **rover** navigates to the **Mars Base**.
4. After reaching the **Mars Base**, the **rover** enters the **base** through the airlock.

5. The taken sample in its sealed container is handed over to the **judges**.

Part 2 | Laboratory (15 min)

1. Astronaut scientists conduct their experiments.

Part 3 | Presentation (10 min)

1. Selection of the starting point of the **rover** in this mission is explained.
2. Photos taken during the mission are shown.
3. The sampling location is indicated, and the photographs taken while sampling are shown.
4. The results of the sample examinations are explained.
5. Stratigraphy of the region should be presented.
6. The results based on any measurements (such as sensors) should be explained.
7. Bonuses, if gathered during the mission, should be presented.

7.1.1.2. Mission Details

Part 1 | Landing & Field Excursion

1. The **rover** starts the mission in the **designated area**, which is described in detail by the **team** in the **science report**. The **designated area** is shown to the field officials by the **judge**. The objectives given by the **judge** must be followed during the placement process. It should clearly be explained in the presentation part why this region was chosen for the test and what types of elements were considered, i.e. vitality, aquatic or geological. It is important to conduct reconnaissance, consistent with the purpose outlined in the **science report.**
2. The soil samples are collected from the location deemed appropriate by the **team**. The sampling process requires the following:
    - The sample must be taken from a depth of at least 5 cm, with a minimum amount of 10 grams.
    - From the moment the sample is taken, it must be stored in an insulated container that will not be exposed to environmental effects to avoid contamination.
    - If any of these requirements are missing, it will not be counted as a full sampling process.
3. After landing, a 360° cylindrical or spherical panoramic photograph of the area is taken. At this stage, **teams** can collect visual data to support their hypothesis. The location where the sample is taken should be photographed with a scale. It is necessary to explain the age relations of the geological units with each other by photographing them. The age relationship of the unit from which the sample was taken with the peripheral units is expected to be specified in the presentation part. For example, coordinate, time, and date information can be obtained in the area where the sample is collected; humidity and temperature measurements can be taken. The data obtained from the instruments, sensors, and the photographs obtained at this stage should be explained in the presentation part.
4. The **rover** goes to the location of the **Mars Base** to deliver the sample and be prepared for the next phase of the mission.
5. The **rover** navigates to the **Mars Base**.

6. After reaching the **Mars Base**, the **rover** enters the **base** through the **airlock.**
7. The taken sample in its sealed container is handed over to the **judges**.

Part 2 | Laboratory (15 min)

1. During the laboratory part, every **team** should follow the lab rules:
    a. **Teams** are not allowed to bring heat installing (electrical, gas, or portable).
    b. **Teams** are not allowed to bring flammable chemicals.
    c. Strong chemicals (4<pH<12) are not allowed to bring more than 100 ml.
    d. All chemicals and devices that will be used during the competition should be declared with a **science report,** if **teams** would not confirm their setup and chemicals before the competition they will not use during the competition.
    e. Each **team** must bring a chemical declaration form before starting experiments. - this declaration will be signed by a **judge** and science **team member**.
    f. Each **team** has to collect disposals before they leave the experimenting area.

Part 3 | Presentation (10 min)

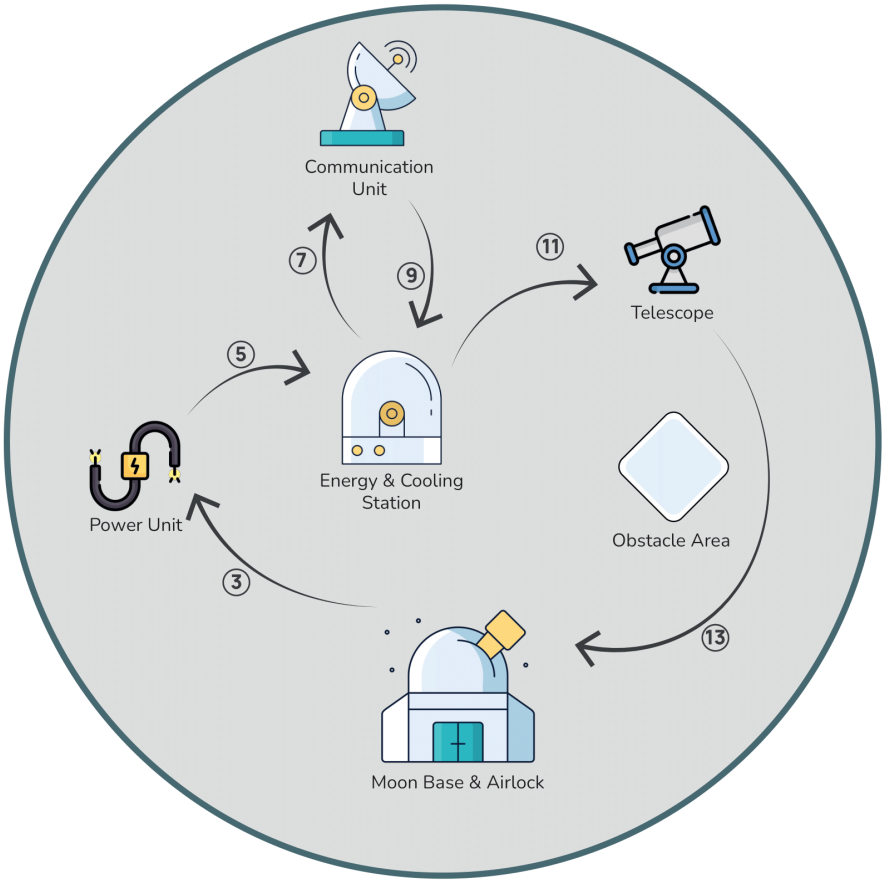
1. A scientific question consistent with the hypothesis as indicated in the previously submitted report is expected to be investigated.
2. The geology of the area is specified using photographs. Observed geomorphological structures are interpreted.
3. The sample location must be consistent with the scientific hypothesis. It is also important that the photographs taken from the sampling area must be scaled.
4. Laboratory results of the collected sample should be reported.
5. The relative age relationships of morphological structures are explained.
6. Each sensor should be explained in terms of why they have been used. Results should be shown.

7.1.1.3. Bonus Scores

1. After the first sample is taken, each extra sample collected at a distance of at least 0.5 meters from each other, up to a maximum of five, will earn bonus scores. All samples must comply with the sampling standard (see Scoreboard).

7.1.2. Mission 2: Far Side of the Moon

Time Limit: 30 min
Mission Field: Moon Field



7.1.2.1. Mission Steps

1. The activity light on the **rover** turns yellow for autonomous driving.
2. The mission starts in the **airlock** of the **Moon Base**.
3. The **rover** navigates to the power unit.
4. The name and operational state data of the power unit are accessed. All of the gathered data is sent to the **Moon Base**.
5. The **rover** navigates to the ECS (Energy and Cooling Station).
6. The **rover** cools its body and recharges.
7. The **rover** navigates to the communication unit.
8. The name and operational state data of the communication unit are accessed. All of the gathered data is sent to the **Moon Base**.
9. The **rover** navigates to the ECS (Energy and Cooling Station).
10. The **rover** cools its body and recharges.
11. The **rover** navigates to the telescope.
12. The name and operational state data of the telescope are accessed. All of the gathered data is sent to the **Moon Base**.
13. The **rover** navigates around the first obstacle.

14. The **rover** arrives back at the **airlock** of the **Moon Base**.

7.1.2.2. Details

1. **Rover** should be able to show its operational status with a lamp. The lamp should have green and yellow colors. The green light should be on when remotely controlled, and the yellow light should be on during autonomous control. While there are no technical restrictions on lamp power and location, reasonable approaches should be expected from **teams**.
2. Before starting the mission, since the manual control of the **rover** violates the rules, the **judge** validates the autonomy of the **rover**. The **judge** has the authority to perform the necessary checks in case of suspicion that the **rover** is being controlled manually. After the validation, the **rover** is placed in the **airlock** by the **team member**s. The list of the locations will be delivered to the relevant **teams** before the mission.
3. Relevant markers are provided in the Technical Details (which will be included in Manual Version 3). The power unit can be detected using these markers. The **rover** must navigate to the power unit and stop next to the power unit to be detected. A penalty will be applied if the **rover** touches the power unit.
4. The **rover** takes data from the Bluetooth of the system without pairing. The data can be read via the device name. The wireless data format is in the Technical Details. The **teams** must save the fixation messages they have read (see the Technical Details for interpretations) for Mission 3. The **rover** sends all the gathered system's name and operational state data to the **Moon Base**. If the data cannot be sent to the **Moon Base**, no scores can be obtained from this step.
5. Relevant markers are provided in the Technical Details. The station can be detected using these markers.
6. The **rover** leaves the cooling station after 15 seconds of cooling. For wireless recharging, the **rover** must be at most 1 meter far from the station.
7. Relevant markers are provided in the Technical Details. The station can be detected using these markers. The **rover** must navigate to the communication unit and stop next to the communication unit to be detected. A penalty will be applied if the **rover** touches the communication unit.
8. The **rover** takes data from the Bluetooth of the system without pairing. The data can be read via the device name. The wireless data format is in the Technical Details. The **teams** must save the fixation messages read (see the Technical Details for interpretations) for Mission 3. The **rover** sends all the gathered system's name and operational state data to the **Moon Base**. If the data cannot be sent to the **Moon Base**, no scores can be obtained from this step.
9. Relevant markers are provided in the Technical Details. The station can be detected using these markers.
10. The **rover** leaves the cooling station after 15 seconds of cooling. For wireless recharging, the **rover** must be at most 1 meter far from the station.

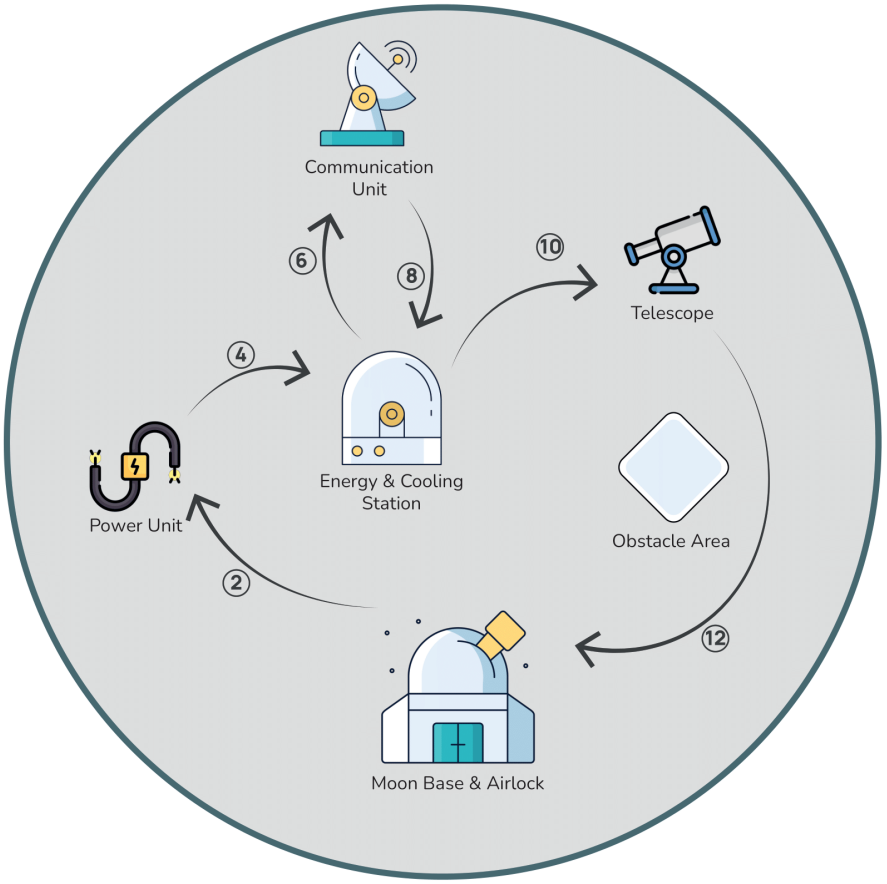
11. Relevant markers are provided in the Technical Details. The telescope can be detected using these markers. The **rover** must navigate to the first station and stop next to the telescope to be detected. A penalty will be applied if the **rover** touches the telescope.
12. The **rover** takes data from the Bluetooth of the system without pairing. The data can be read via the device name. The wireless data format is in the Technical Details The **teams** must save the fixation messages read (see the Technical Details for interpretations) for Mission 3. The **rover** sends all the gathered system's name and operational state data to the **Moon Base**. If the data cannot be sent to the **Moon Base**, no scores can be obtained from this step.
13. The **rover** passes around the obstacle to reach the **airlock** of the **Moon Base**.
14. When the **rover** navigates to the **Moon Base** from the telescope, it is expected for the **rover** to be placed into the **airlock**. There are markers on the two sides of the entrance of the **airlock** of the **Moon Base**. The **rover** should enter the **airlock** by passing in between these two sides. Relevant markers are in the Technical Details.

7.1.2.3. Notes

The **team** loses some points (see the penalties) if the **rover** stays on the surface of the Moon for more than 10 minutes without cooling i.e not going to the ECS or the **Moon base.**

7.1.3. Mission 3: Saving the Home

Time Limit: 30 min
Mission Field: Moon Field



7.1.3.1. The Mission Steps

1. The mission starts in the **airlock** of the **Moon Base**.
2. The **rover** navigates to the Power Unit.
3. After reaching the Power Unit, the **rover** manipulates the proper switches to reboot the system.
4. The **rover** then navigates to the ECS (Energy and Cooling Station).
5. The **rover** cools its body and waits while recharging.
6. The **rover** navigates to the Communication Unit.
7. The **rover** manipulates proper switches on the panel of the Communication Unit.
8. The **rover** then navigates to the ECS (Energy and Cooling Station).
9. The **rover** cools its body and waits while recharging.
10. The **rover** navigates to the Telescope.
11. The **rover** manipulates proper switches on the panel of the Telescope.
12. The **rover** then returns to the **airlock**.

7.1.3.2. Details

1. The **rover** starts the mission in the **airlock** of the **Moon Base**. From there, the **rover** should visit all the three systems that were visited earlier in the autonomous mission and fix the malfunctions of these systems.
2. After the **rover** leaves the **airlock**, it moves to the Power Unit. The location of the Power Unit will be provided to the **teams** before the challenge. A 2 meters radius circle surrounds the Power Unit. To get points from this step, the **rover** has to be in this circle.
3. The Power Unit has a panel which contains proper switches, buttons, etc. To get full points on this step the **rover** has to do all ordinary manipulations on the panel which is dictated in the manual. To see blueprints of the panel and get all the necessary information, check the related page in the Technical Details section for the Power Unit.
4. The location of the ECS will be provided to the **teams** before the challenge. A 2 meters radius circle surrounds the ECS. To get points from this step **rover** has to be in this circle.
5. The **rover** waits for 15 seconds in the circle.
6. After the **rover** leaves the ECS, it moves to the Communication Unit. The location of the Communication Unit will be provided to the **teams** before the challenge. A 2 meters radius circle surrounds the Communication Unit. To get points from this step **rover** has to be in this circle.
7. The Communication Unit has a panel which contains proper switches, buttons, etc. To get full points on this step the **rover** has to do all ordinary manipulations on the panel which is dictated in the manual. To see blueprints of the panel and get all the necessary information, check the related page in the Technical Details section for the Communication Unit.
8. The location of the ECS will be provided to the **teams** before the challenge. There is a circle around the ECS which is 2 meters in radius. To get points from this step **rover** has to be in this circle.
9. The **rover** waits for 15 seconds in the circle.
10. After the **rover** leaves the ECS, it moves to Telescope. The location of the Telescope will be provided to the **teams** before the challenge. A 2 meters radius circle surrounds the Telescope. To get points from this step **rover** has to be in this circle.
11. The Telescope has a panel which contains proper switches, buttons, etc. To get full points on this step the **rover** has to do all ordinary manipulations on the panel which is dictated in the manual. To see blueprints of the panel and get all the necessary information, check the related page in the Technical Details section for the Telescope.
12. The **rover** completes the mission by entering the **airlock**.

7.1.3.3. Bonus Scores

1. The **rover** must learn from Mission 2 ordinary information to manipulate the panels .(The information obtained in Mission 2 includes necessary details for all units.)
2. The **rover** manipulates proper switches autonomously in the Power Unit.

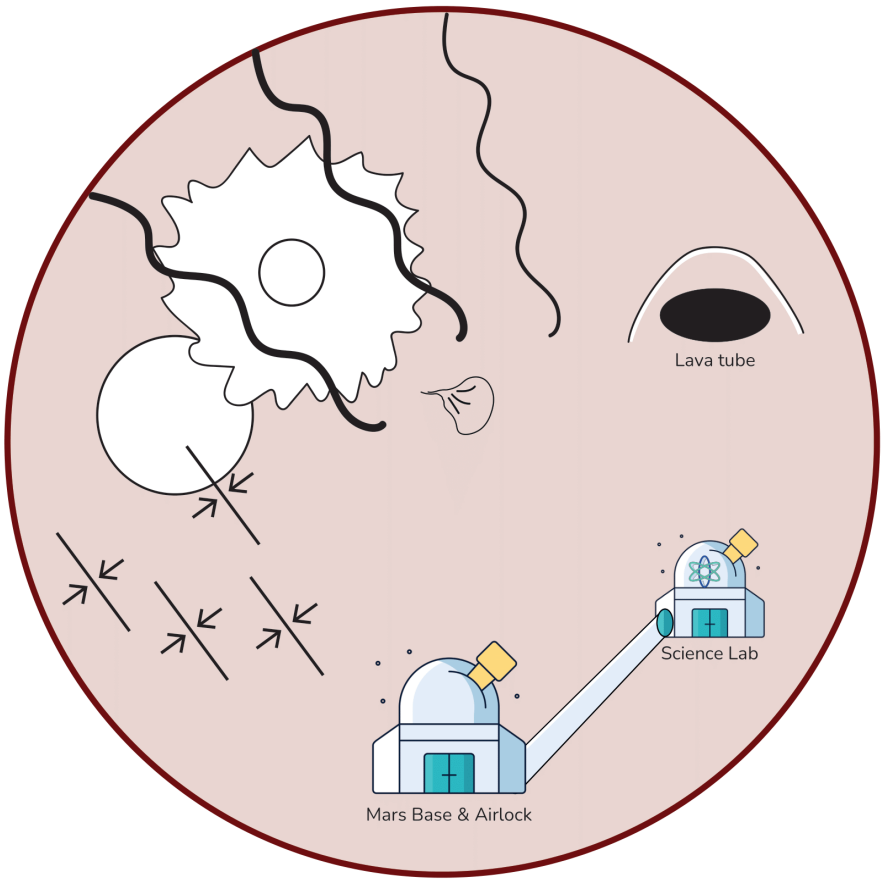
3. The **rover** manipulates proper switches autonomously in the Communication Unit.
4. The **rover** manipulates proper switches autonomously in the Telescope.

7.1.3.4. Notes

1. The **team** loses some points (see the penalties) if the **rover** stays on the surface of the Moon for more than 10 minutes without going to ECS or the **Moon Base**.
2. The **team** loses some points (see the penalties) if the **rover** causes any damage to the panels of the systems.

7.1.2. Mission 4: Karain

Time Limit: 15 min
Mission Field: Mars Field
Mission Time: After sunset!



7.1.2.1. The Mission Steps

1. The **rover** starts the mission inside the **airlock**.
2. The **rover** navigates to point B.
3. From point B the **rover** tracks the footsteps of astronauts and navigates to point C.
4. From point C the **rover** tracks the footsteps of astronauts and navigates to the entrance of the lava tube.
5. The **rover** enters the lava tube.
6. The **rover** finds the astronauts.
7. The **rover** takes pictures of the astronauts.
8. The **rover** exits the lava tube.
9. The **rover** navigates back to the **airlock**.
10. The **rover** enters the **airlock**.

7.1.2.2. Details

1. The **rover** starts the mission in the **airlock** of the **Mars Base**.
2. The location of point B will be shared with the **teams** before the challenge begins. A 2 meters radius circle surrounds point B. To get points from this step the **rover** should be in the circle.
3. From point B to point C there are visible (highlighted) footsteps of astronauts on the **mission field**. The **rover** should track these steps and find the point C. There is a much bigger highlighted area which is 2 meters in diameter. To get points from this step the **rover** should be in this highlighted area.
4. From point C to the entrance of the lava tube there are visible (highlighted) footsteps of astronauts on the **mission field**. The **rover** should track these steps and find the entrance of the lava tube. There is a circle in front of the entrance of the lava tube which is 2 meters in diameter. To get points from this step the **rover** should be in the circle.
5. The **rover** should enter the lava tube without touching the borders of it. In any interference with lava tube point deduction will be applied.
6. In the lava tube the **rover** should find the missing astronauts. There is a circle in front of the astronauts which is 2 meters in diameter. To get points from this step the **rover** should be in this circle.
7. The **rover** should take pictures of all astronauts and send them back to the **Mars Base**.
8. The **rover** should exit the lava tube without interfering with the boundaries of the lava tube. In any interference with lava tube point deduction will be applied.
9. The **rover** should navigate back to the known location of the **airlock**.
10. The **rover** should enter the **airlock** so that no part of it is left outside of the **airlock**.

7.2. Side Missions

7.2.1. Challenge to Shine

Time limit: 10 minutes with each **judge**

This small side challenge is a presentation challenge to be made to experts in their fields. The presentations made in this challenge are evaluated separately and not be included in the general challenge score. The fields of the experts are science, autonomous driving and control, robotic arm, driving in difficult terrain, and **team** structure, etc. (see ARC Manual v.2.). **Team members** will have 10 minutes to present their approach to the stated fields during this challenging process to the **judges** in different rooms. The presentations will be evaluated, and the **judges** will choose the winner of each field. Prizes will be given to the winning **teams**. Each field can only have one winner.

7.2.2. Side-Challenges

During challenge days, there will be side-challenges which are not a part of the main challenge. These challenges are a set of games and mostly require **rover-teammate** interaction. All of the winners will get special awards. Some of the planned side-missions are stated in this section. The ARC Committee has all rights to make changes to side-challenges until the competition day. Side-challenge winners will be awarded in all categories.

7.2.2.1. Tug of Challenge

Two **teams** play tug-of-war, with only **team member**s or only **rovers**. **Rovers** can pull the rope tied.

7.2.2.2. Dance Challenge + Victoria's Rover

Teams decorate their **rovers**. **Rover** takes a tour on the runway. After the tour, the **rover** performs a dance choreography with at least two members of the **team**. It is up to the imagination of the **team members**. Traditional clothing and dances are encouraged.

7.2.2.3. Rover Jenga

Rovers and optionally, team-mates will play with **Rover-**sized Jenga pieces. It can also be played by the participants, optionally. They should be careful and precise so as not to drop the blocks.

7.2.2.4. Egg and Rover Challenge

The **rovers** will carry a special space egg on a special spoon without cracking the egg. The important thing is balance of the **rover**; the drivetrain and robotic arm capabilities will be challenged.

7.2.2.5. Ring Challenge

Rovers try to pass a ring through a specially made metal pipe. **Rover's** arm should not be shaken in order not to touch the pipe.

7.2.2.6. Rover Art

Rover draws a picture using a robotic arm.

7.2.2.7. Roverelay

2 people from each **team** and their **rover** play the relay race. The race is held for a total of 250 meters. The first **team member** should achieve the first 100 meters. Then the **rover** moves for 50 meters. Finally, the second **team member** finishes the last 100 meters. This is a **team** game, so no **team member** or the **rover** should be left behind.

7.2.2.8. Squid Rover

It is a "Red light-green light" game. When the seeker turns around, the red light turns on and the moving competitor is eliminated. 2 **team members** from each **team** and the **rover** participate in this competition. The movement precision of the **rovers** is important.

7.2.2.9. Nascarover

A track with curves and different terrain conditions are prepared and the **rovers** race on this track (Our competition area can be turned into a track.). **Rovers** should have good terrain control.

7.2.2.10. Cornerover

If there are x number of **rovers** to compete, there will be x-1 number of corners. When the whistle blows, all the **rovers** try to get into a corner. The one left out is eliminated (like a chair-grabbing game). The speed of the **rovers** will be in the foreground.

7.2.2.11. Roverteering

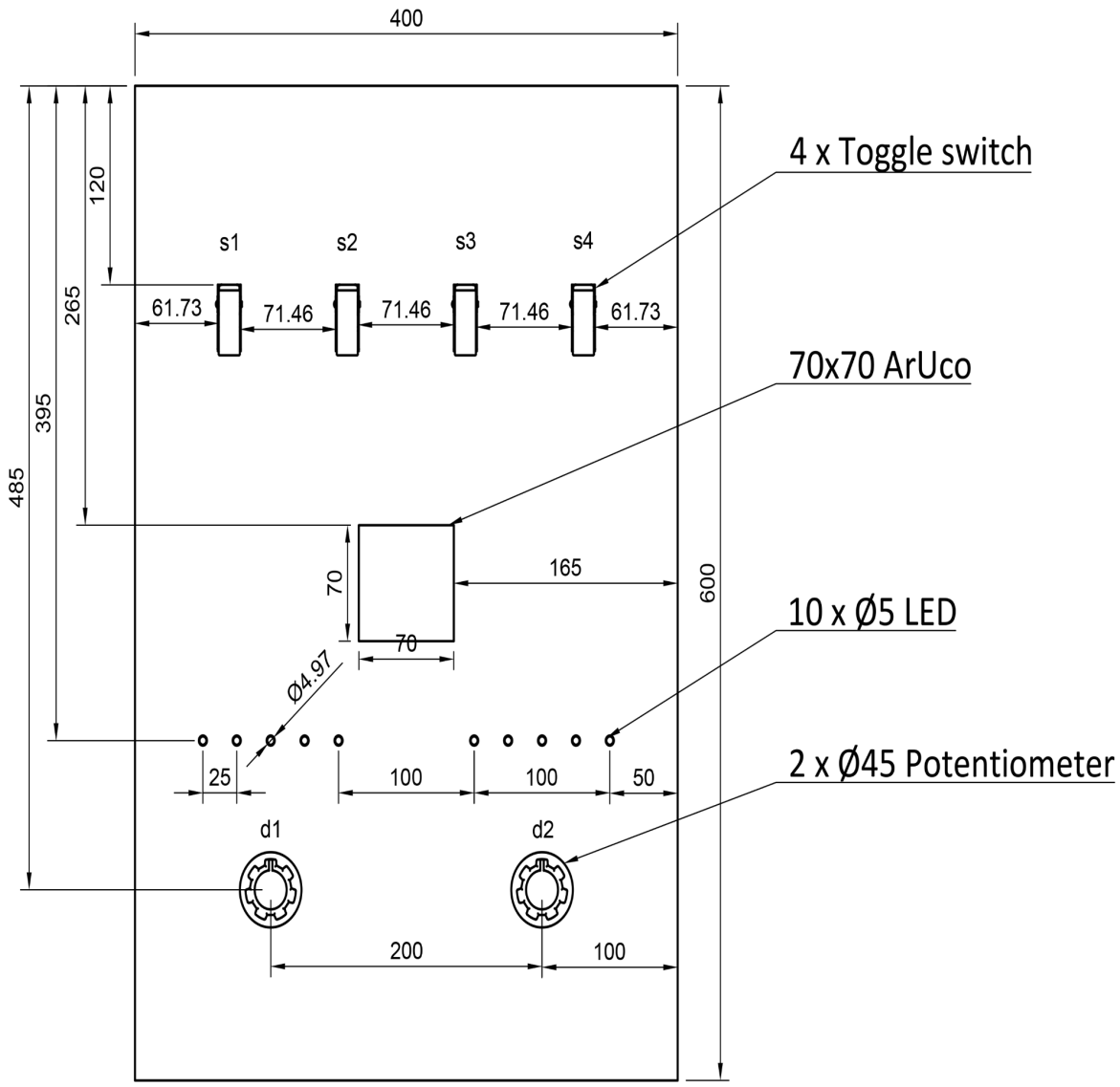
It is aimed to find the treasure in a few steps by following the signs given to the competitors in accordance with the instructions given in advance.

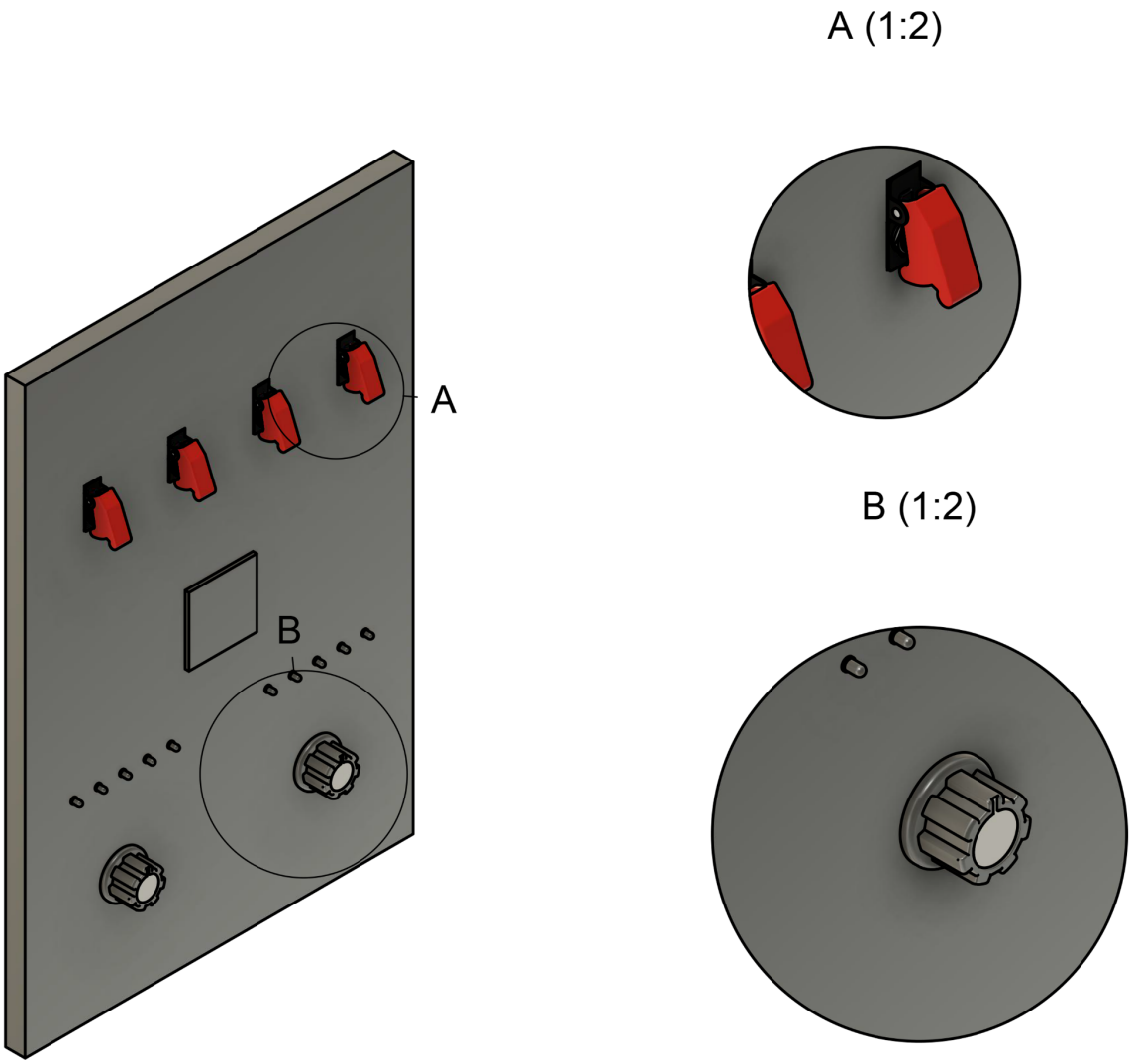
8. Technical Details

Please note that all measurements may have a margin of error.

8.1. Power Unit

8.1.1. Panel Sketch





8.1.2. Panel Steps

1. The **rover** turns the first switch on.
2. The **rover** turns the second switch on.
3. The **rover** rotates the first dimmer completely.
4. The **rover** rotates the second dimmer completely.

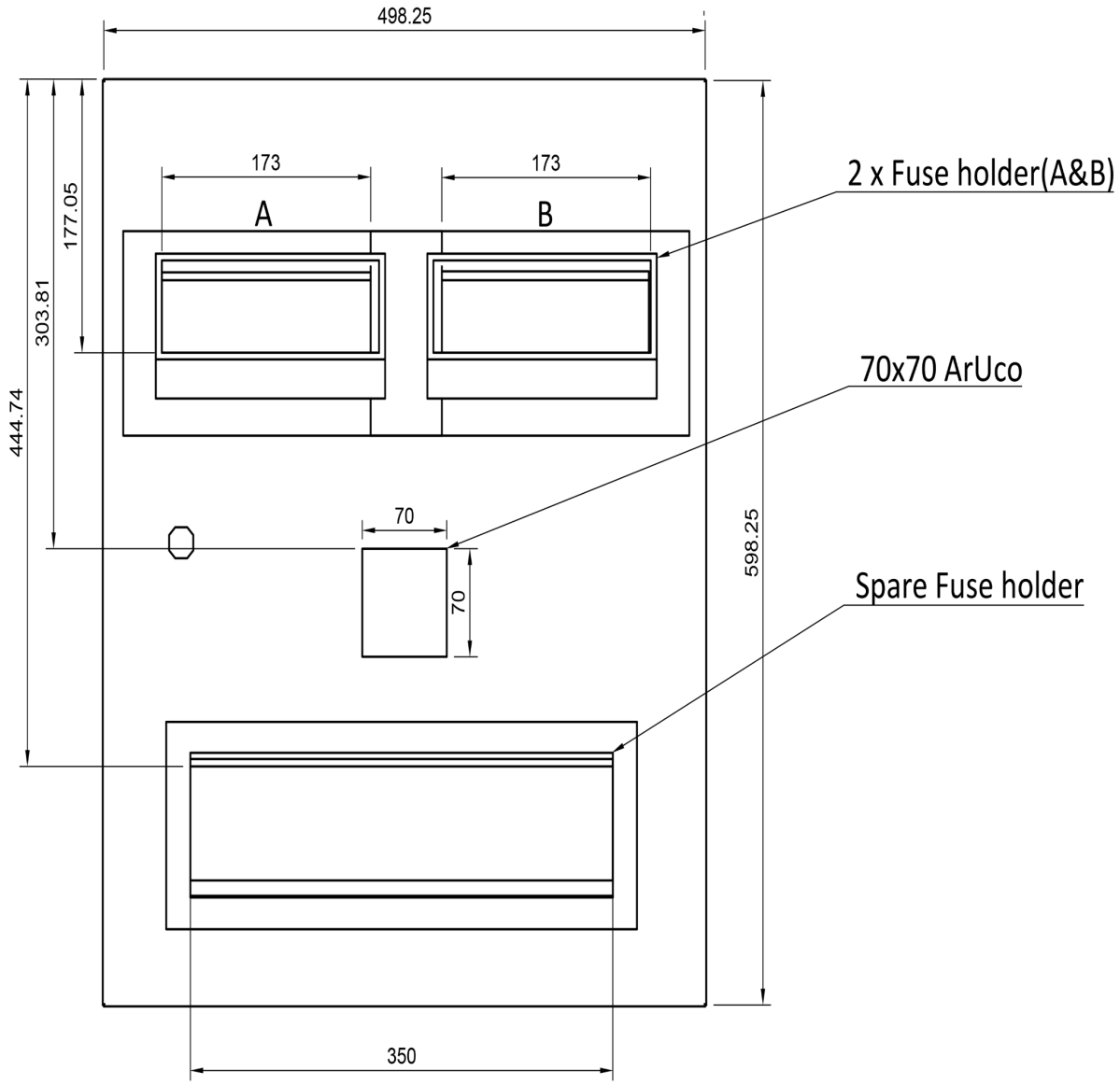
8.1.3. Panel Details

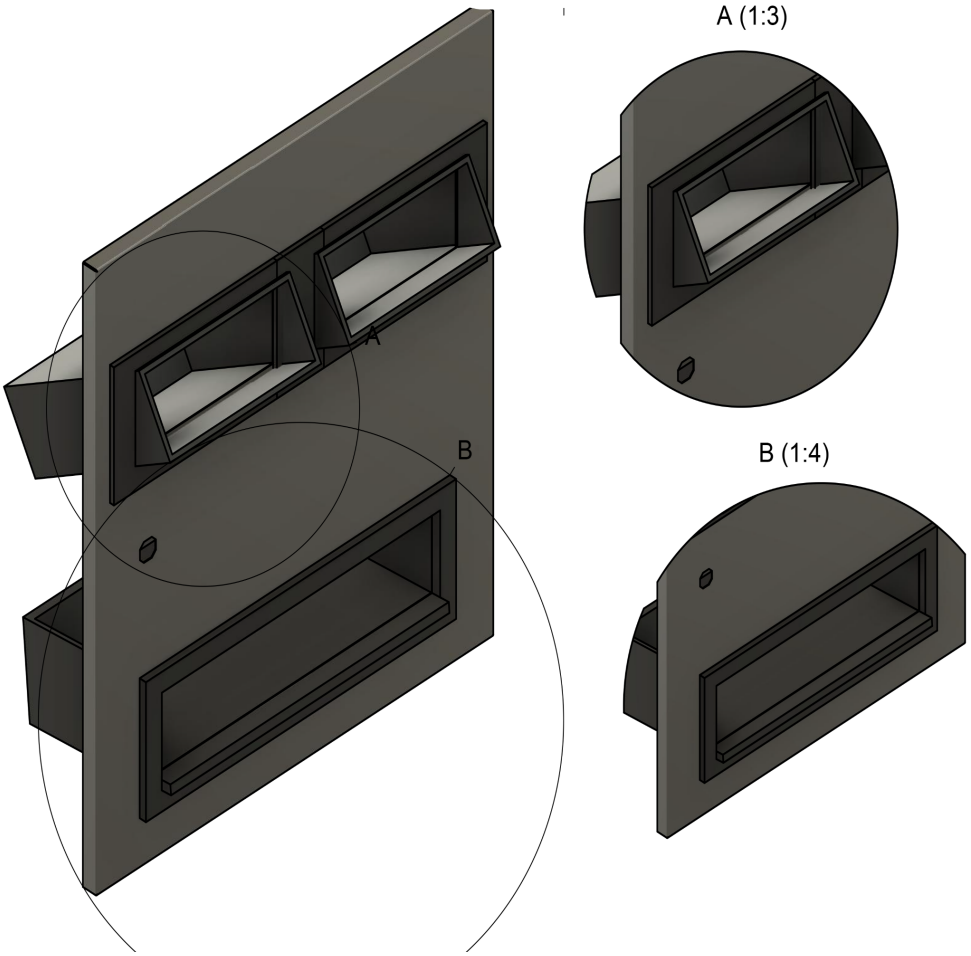
1. The **rover** should turn the first switch out of 4 on. **Teams** will get an order of the switches from the second mission, if they could not, the information will be provided by the juries.
2. The **rover** should turn the second switch on. The same rules applied as Power Unit Panel Details 1.

3. The **rover** should rotate the first dimmer fully on. There are 5 LEDs on the dimmer. Each led represents 72 degrees of rotation. When the dimmer is fully on all of the 5 LEDs will be lit.
4. The **rover** should rotate the first dimmer fully on. The same rules applied as Power Unit Panel Details 3.

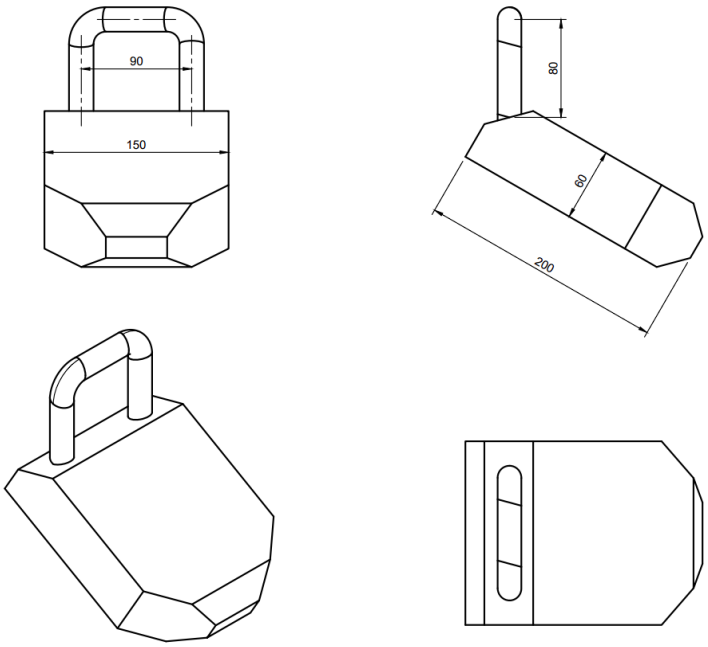
8.2. Communication Unit

8.2.1. Panel Sketch





8.2.2. Fuses



8.2.3. Panel Steps

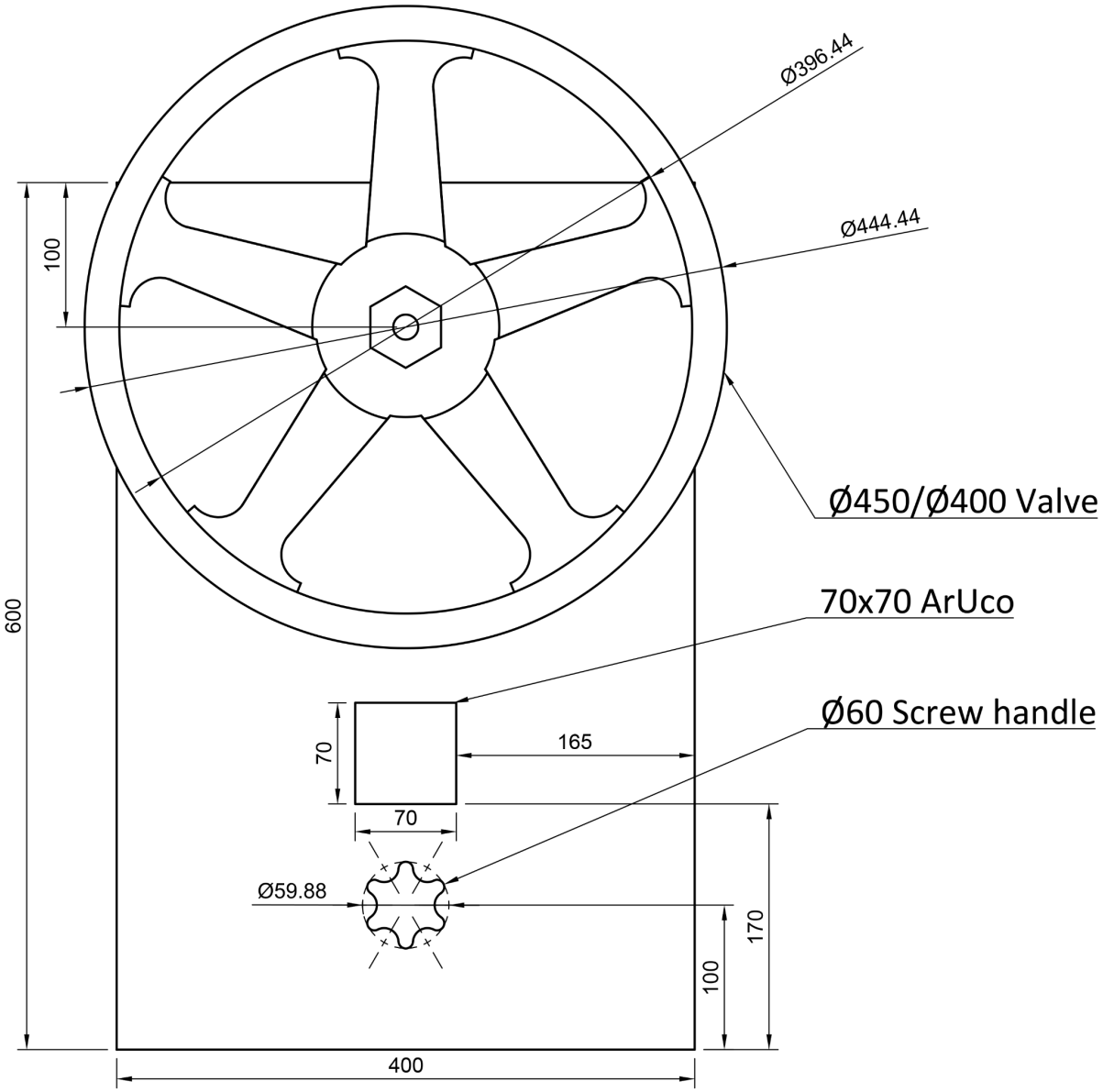
1. The **rover** takes the broken switch off.
2. The **rover** puts the broken switch to the spare fuse holder.
3. The **rover** takes the new switch and puts it in the fuse holder.

8.2.4. Panel Details

1. The **rover** should take the broken switch out of the fuse holder. In the default panel configuration, there are two switches on the fuse holder; one of them is broken and the other is working, while the new one is on the spare fuse holder. **Teams** might get information about which switch is broken from Mission 2.
2. The **rover** should put the broken switch on the spare fuse holder next to the new one.
3. The **rover** should take the new switch which is on the spare fuse holder and put it in the fuse holder.

8.3. Telescope

8.3.1. Panel Sketch



8.3.2. Panel Steps

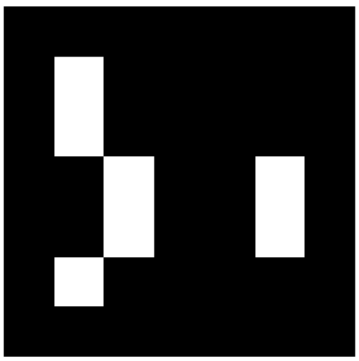
1. The **rover** rotates the screw handle for 360 degrees.
2. The **rover** rotates the big valve 90 degrees and in the specified direction.

8.3.3. Panel Details

1. The **rover** should rotate the screw handle 360 degrees. There will be marks on the screw handle to represent a 360 degrees rotation.
2. The **rover** should rotate the valve 90 degrees. **Teams** should get information about the direction of rotation (clockwise or counterclockwise) from Mission 2. There will be marks on the panel to represent the rotation angle.

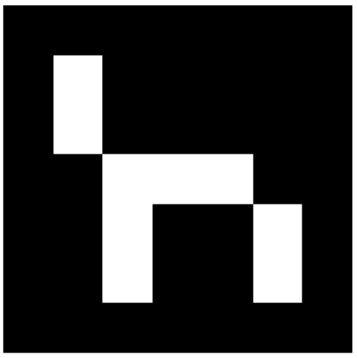
8.4. Markers

1. **M1**



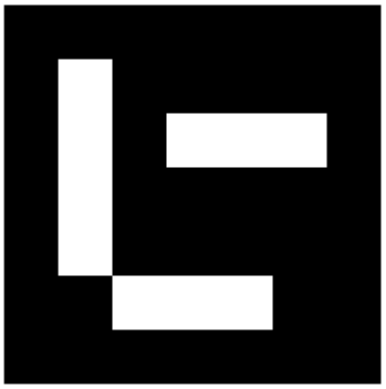
(The marker on the Power Unit)

2. **M2**



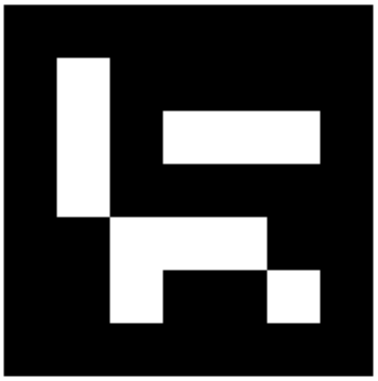
(The marker on the Energy and Cooling Station)

3. **M3**



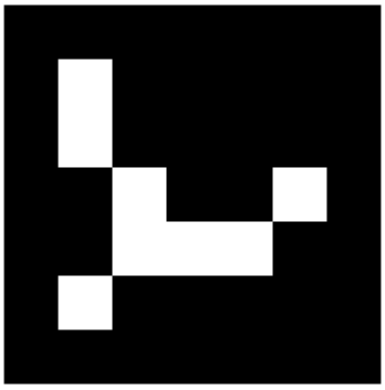
(The marker on the Communication Unit)

4. **M4**



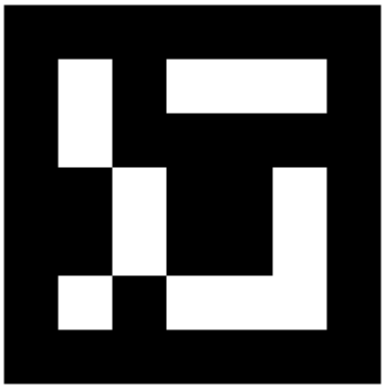
(The marker on the Telescope)

5. **M5**



(The marker on the right-hand side of the Airlock)

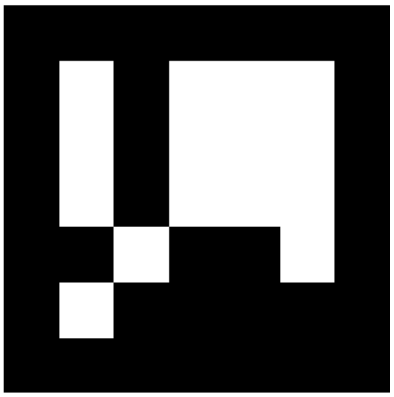
6. **M6**



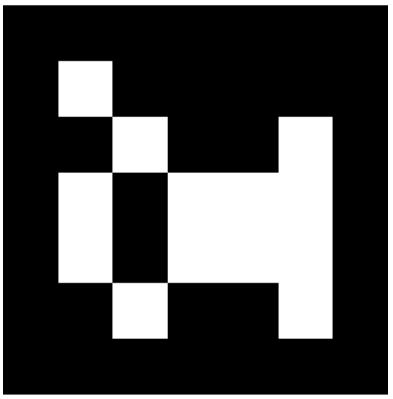
(The marker on the left-hand side of the Airlock)

7. **M7**

8. **M8**

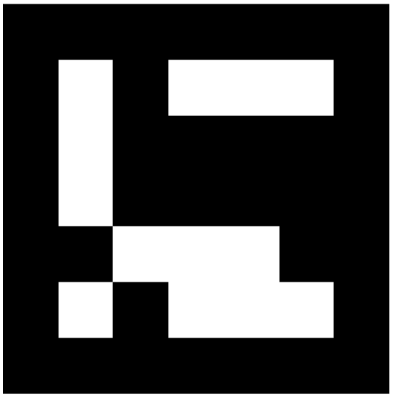


(The marker inside the Airlock)



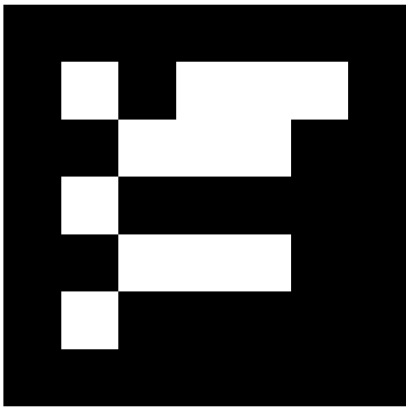
(The marker on the panel of the Power Unit)

9. M9



(The marker on the panel of the Communication Unit)

10. M10



(The marker on the panel of the Telescope)

8.5. Bluetooth Format

1. The data is in the name of the Bluetooth device; therefore, the **rover** does not need to pair the device.
2. Different devices are used for different **teams**, and Bluetooth MAC addresses of the devices are shared with **teams** before the mission to read data from the correct device.
4. The fixation messages for different systems differ as follows: In the power unit there are 4 numbered switches, the **teams** should read fixation messages in order to determine which ones to switch on. Similarly, in the Communication unit the **teams** should read the fixation messages to determine which fuse to replace. In the Telescope unit the **teams** should read fixation messages in order to determine the direction of the rotation (clockwise/ counterclockwise).
5. The device name is "name: name_of_the_system; fix: fixation_message"
6. Example of the device name: name: Power Unit; fix: 1,4
   name: Communication Unit; fix: A
   name: Telescope Unit; fix: counterclockwise

9. Score Tables

9.1. Final Qualification

Finals Qualification scores are calculated according to the following formula:
0.45 x Design Report Score + 0.45 x Video Presentation Score + IRDC Scaled Score.
IRDC Scores are scaled such that the maximum possible score is 10 points.

9.1.1. Design Report

Design Report scores will not affect mission scores, but affect the elimination process to select the finalist **teams**. The scoring will be conducted by the following table.

No	Title	Description	Detail	Score
1	Team Info	Team Name	Name of the team and if applied, name of the rover.	1
2		Contact	Contact information and social media links of the team	1
3		Academic Institution	Name and address of the affiliated academic institution.	1
4		Academic Consultant	Name, affiliated academic institution and contact information of academic consultant.	1
5		History of the team	A paragraph of team history including foundation date, attended competitions and experience.	5
6		Active Members List	A table of active members including following information: Name (or initial letters), University Major, and duty in the team.	2
7		Team Photo	A photo/screenshot of the whole or part of the team.	1
8	Management	Work Calendar	Explain the work on the project by a gantt chart. Include 10-15 items in the Gantt chart.	10
9		Team Formation	How is the team workforce structured? (2-3 sentences) Include a graphic to explain the structure as well.	5
10		Workplace	How does the team design, build and test the rover physically? Explain the workplace. (2-4 sentence) Include a photo/screenshot of the workplace.	3
11		Funding	How are the funds of the project at the time of submission of this document?	2
12			How much spending is expected for the development costs? How much spending is expected for the travel costs?	2
13			What is the team's plan in an insufficient funding situation by the competition date?	2
14		Logistics	What is the team's plan to package and bring the rover to the competition site by July? (4-6 sentences)	4

No	Title	Description	Detail	Score
15	Rover Design	Mobility system	What is used? Describe the system (3-5 sentence)	2
16			Why is the system chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentence)	2
17			Unique points and inspirations (3-5 sentence)	2
18			Visuals of the system (2 photo/screenshots)	2
19			Technical Specifications including mass and size (3-5 sentence)	2
20			Discuss system's adequacy for its role in competition missions. (3-5 sentence)	2
21		Electronics and power system	What is used? Describe the system (3-5 sentence)	2
22			Why is the system chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentence)	2
23			Unique points and inspirations (3-5 sentence)	2
24			Visuals of the system (2 photo/screenshots)	2
25			Technical Specifications including mass and battery duration (3-5 sentence)	2
26			Discuss system's adequacy for its role in competition missions. (3-5 sentence)	2
27		Manipulation system	What is used? Describe the system (3-5 sentence)	2
28			Why is the system chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentence)	2
29			Unique points and inspirations (3-5 sentence)	2
30			Visuals of the system (2 photo/screenshots)	2
31			Technical Specifications including mass, max payload and size (3-5 sentence)	2
32			Discuss system's adequacy for its role in competition missions. (3-5 sentence)	2
33		Science Payload	What is used? Describe the system (3-5 sentence)	2
34			Why is the system chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentence)	2
35			Unique points and inspirations (3-5 sentence)	2
36			Visuals of the system (2 photo/screenshots)	2
37			Technical Specifications including mass and sensors (3-5 sentence)	2
38			Discuss system's adequacy for its role in competition missions. (3-5 sentence)	2

No	Title	Description	Detail	Score
39		Ground station equipment and communication system	What is used? Describe the system. (3-5 sentence)	2
40			Why is the system chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentence)	2
41			Unique points and inspirations (3-5 sentence)	2
42			Visuals of the system (2 photo/screenshots)	2
43			Technical Specifications including resilience to noise and communication range (3-5 sentence)	2
44			Discuss system's adequacy for its role in competition missions. (3-5 sentence)	2
TOTAL				**100**

9.1.2. Video Presentation

Video Presentation scores will not affect mission scores but affect the elimination process to select the finalist **teams**. The scoring will be conducted by the following table.

No	Title	Description	Detail	Score
1	Team Info	Team Name	Name of the team and if applies, name of the rover.	1
2		Academic Institution	Name of the afilliated academic institution.	1
3		History of the team	The team's history including foundation date, attended competitions and experience.	3
4		Team Photo	A photo/screenshot of the whole or part of the team.	3
5	Management	Workplace	How the team design, build and test the rover physically? Explain the workplace.	2
6	Rover Design	Mobility system	What is used? Describe the system.	1
7			Technical Specifications including mass and size.	1
8			Why the system is chosen? What are the considerations?	1
9			Visuals of the system to show mechanisms.	3
10			Demonstration of the system with ARC'23 mission objectives in mind.	8
11		Electronics and power system	What is used? Describe the system.	1
12			Technical Specifications including mass and size.	1
13			Why the system is chosen? What are the considerations?	1
14			Visuals of the system to show mechanisms.	3

15			Demonstration of the system with ARC'23 mission objectives in mind.	8
16		Manipulation system	What is used? Describe the system.	1
17			Technical Specifications including mass and size.	1
18			Why the system is chosen? What are the considerations?	1
19			Visuals of the system to show mechanisms.	3
20			Demonstration of the system with ARC'23 mission objectives in mind.	8
21		Science Payload	What is used? Describe the system.	1
22			Technical Specifications including mass and size.	1
23			Why the system is chosen? What are the considerations?	1
24			Visuals of the system to show mechanisms.	3
25			Demonstration of the system with ARC'23 mission objectives in mind.	8
26		Ground station equipment and communication system	What is used? Describe the system.	1
27			Technical Specifications including mass and size.	1
28			Why the system is chosen? What are the considerations?	1
29			Visuals of the system to show mechanisms.	3
30			Demonstration of the system with ARC'23 mission objectives in mind.	8
31		Whole Rover	Demonstration of the system with ARC'23 mission objectives in mind.	10
32	Video Clarity		Quality of the content and presentation	10
TOTAL				**100**

9.1.3. IRDC and World Rover League

International Rover Design Challenge (IRDC) is an online space engineering design and research competition by the Space Robotics Society (SPROS) & Space Exploration Society (UKET) for 2023. It challenges university students to conceptualize and design Next-Gen Mars Rovers, which shall be fully equipped and mission ready for future astronaut-assistive exploration operations on Mars. **Teams** are supposed to carefully plan each sub-system of the Rover, considering various extraterrestrial parameters in its design. This online research-oriented competition is designed for students to explore their minds and spark the innovative design thinking of individuals, free from constraints on available physical resources. This year, IRDC scores will contribute 10% to final qualifications.

The World Rover League (WRL) is a global space robotics league for university students organized by SPROS and UKET in which **teams** conceptualize, design, develop, and operate an astronaut-assistive next-generation planetary **rover** in simulated conditions. The WRL season runs from March to January, with **teams** competing in three competitions: the International Rover Design Challenge, the **Anatolian Rover Challenge**, and the International Rover Challenge.

The calendar for the WRL and the rulebook for IRDC 2023 will be announced on March 5, 2023. See https://roverchallenge.org/ for further announcements.

9.2. Finals Scoring

Challenge scores are given in the table below. **Teams** are evaluated with the sum of the points they get from all missions at the end of the challenge. The top three **teams** that get the maximum overall points will be selected as winners and awarded respectively.

9.2.1. Mission 1 (Mars Field)

Mission 1 will be scored according to the table below.

No	Parameter	Step Score	Detailed Explanation
1.1	Sampling	10	2 points for each cm of depth, without mixing with the sediments above. If it is mixed, no points will be gathered in this step
1.2		10	1 point for each gram of sample, minimum 10 grams of sample is expected. However, the maximum point in this step is 10 points. More than 10 grams will not provide extra points.
2	Getting to the base	5	The rover has to arrive at the location of the Mars Base.
3	Entering the airlock	10	It must fit snugly in the airlock. No part of it must come into contact with the airlock.
4	Suitability of the chosen sampling area to verify the hypothesis	15	
5	Presenting the panoramic photographs of the area	5	The photographs must be taken during the mission.
6	Explaining the panoramic photographs of the area	5	The geomorphology of the region must be interpreted from the photograph.
8	Explaining the sampling site based on hypothesis	15	The selected sampling site must be consistent with the scientific hypothesis.
9	Identification of the sample given by the juries	10	The physical properties and significance of the sample for the hypothesis must be described.
10	Explaining the appropriateness of the experiments performed on the sample given by the juries based on the hypothesis	15	Each experiment performed to test the scientific hypothesis has extra scores. If the experimental methodology is inconsistent with the hypothesis, no scores can be obtained.
11	Interpreting the results of the experiments	10	The result of the experiment must be explained in the context of the scientific hypothesis. Rejecting or confirming the hypothesis must be explained with their

			reasons.
12	Presenting the sampling photographs	5	The photograph must be scaled, and it must be gathered during this mission.
13	Explaining the sampling photographs	10	Geomorphological structures in the region must be evaluated in terms of time relations. The geological history of the region must be explained using photographs of the cross-cutting structures. To define the relative age of the unit, in which the sample was taken, it should be compared with the other units in the area.
14	Demonstrating the data of the sensors and additional sensor measurements	5	Data must be gathered during this mission.

No	Parameter	Bonus Score	Detailed Explanation
1	Extra sample	10	It should follow the entire sampling process. If any requirement of the full sampling process is missing, no points will be gathered.

9.2.2. Mission 2 (Moon Field)

Mission 2 will be scored according to the table below.

No	Parameter	Step Score	Detailed Explanation
1	Turning on activity light	6	The rover must turn activity light yellow.
2	Stopping next to the power unit	11	The rover must go to the given location of the power unit.
3	Sending name accessed from the system to the Moon Base	5	Data accessed via wireless data transmitter must be sent to the Moon Base to evaluate.
4	Sending operational status accessed from the system to the Moon Base	7	Data accessed via wireless data transmitter must be sent to the Moon Base to evaluate.
5	Stopping next to the energy and cooling station	11	The rover must go to the given location of energy and cooling station.
6	Recharging rover	12	The position of the cooling and charging station is indicated by a circle with a diameter of 1 meter. Teams must

			take the rover to this circle.
7	Cooling for given amount of time	8	The rover cools for at least 15 seconds by standing around 2 meters from the station.
8	Stopping next to the communication unit	11	The rover must go to the given location of the communication unit.
9	Sending name accessed from the system to the Moon Base	5	Data accessed via wireless data transmitter must be sent to the Moon Base to evaluate.
10	Sending operational status accessed from the system to the Moon Base	7	Data accessed via wireless data transmitter must be sent to the Moon Base to evaluate.
11	Stopping next to the energy and cooling station	11	The rover must go to the given location of the energy and cooling station.
12	Recharging rover	12	The position of the cooling and charging station is indicated by a circle with a diameter of 1 meter. Teams must take the rover to this circle.
13	Cooling for given amount of time	8	The rover cools for at least 15 seconds by standing around 2 meters from the station.
14	Stopping next to the telescope	11	The rover must go to the given location of the telescope.
15	Sending name accessed from the system to the Moon Base	5	Data accessed via wireless data transmitter must be sent to the Moon Base to evaluate.
16	Sending operational status accessed from the system to the Moon Base	7	Data accessed via wireless data transmitter must be sent to the Moon Base to evaluate.
17	Navigating around the obstacle	8	The rover must navigate around the obstacle to go to the Moon base.
18	Getting in front of the airlock	10	For the rover to enter the airlock, it must go to front of the airlock.
19	Getting in through the airlock	20	The rover must enter the airlock with the help of the markers on the Moon Base.
20	Doing all steps of the mission in a single attempt	25	The rover must not repeat any steps of the mission.

No	Penalties	Step Score	Detailed Explanation
1	Detection of the rover being remotely controlled during the mission	-100%	No scores can be taken from the mission.
2	Damage to objects on the field	-10%	Resulting in a 10% deduction from the team's total Mission 2 scores for each object damaged.
3	Touching the systems	-5%	Result in a 5% deduction from the team's total Mission 2 scores for each touching
4	Any part of the rover going out of the field	-5%	Scores are broken and continue from the last successful step of the mission.
5	Shutting down the rover with communication	-5%	Because an emergency has occurred that the red button could not be reached.
6	Repetition of the mission step	-20% (step score)	For each repetition of the step, 20% of the step score is deducted. e.g repeating the second step (10 points) 2 times deducts 4 points from the mission score.
7	Not visiting the ECS after 10 minutes	-2%	Result in a 2% deduction from the team's total Mission 2 scores for each minute passed from visiting the energy and cooling system.

9.2.3. Mission 3 (Moon Field)

Mission 3 will be scored according to the table below.

No	Parameter	Step Score	Detailed Explanation
1	Navigating to the Power Unit	3	The rover must be in the circle around the Power Unit
2	Turning on the switch 1	5	The rover must turn on the right switch according to information
3	Turning on the switch 2	5	The rover must turn on the right switch according to information
4	Rotating the dimmer 1	10	The rover must rotate the dimmer 1 till all the LEDs are on
5	Rotating the dimmer 2	10	The rover must rotate the dimmer 2 till all the LEDs are on
6	Navigating to the ECS	3	The rover must be in the circle around the ECS
7	Waiting next to the ECS	3	The rover must wait for 15 seconds
8	Navigating to the Communication Unit	3	The rover must be in the circle around the Communication Unit

9	Changing the fuse on the Communication Unit	15	The rover must remove the broken fuse
10		5	The rover must put the broken fuse into the spare fuse holder
11		20	The rover must insert the new fuse
12	Moving to the ECS	3	The rover must be in the circle around the ECS
13	Waiting next to the ECS	3	The rover must wait for 15 seconds
14	Moving to the Telescope	3	The rover must be in the circle around the Telescope
15	Rotating the screw handle	15	The rover must rotate the bolt clockwise for 360 degrees
16	Rotating the valve	20	The rover must rotate the valve for proper direction for 90 degrees
17	Getting back into the airlock	4	The rover must enter the airlock

No	Parameter	Bonus Score	Detailed Explanation
1	Using information for Power Unit	3	The rover must learn from Mission 2 the information about the state of unit
2	Using information for Communication Unit	3	The rover must learn from Mission 2 the information about the state of unit
3	Using information for Telescope	3	The rover must learn from Mission 2 the information about the state of unit
4	Turning on the switch 1	5	The rover must do this task autonomously
5	Turning on the switch 2	5	The rover must do this task autonomously
6	Rotating the dimmer 1	5	The rover must do this task autonomously
7	Rotating the dimmer 2	5	The rover must do this task autonomously
8	Changing the fuse	5	The rover must do this task autonomously
9	Rotating the screw handle	5	The rover must do this task autonomously
10	Rotating the valve	6	The rover must do this task autonomously

No	Penalties	Mission Score	Detailed Explanation
1	Not visiting the ECS after 10 minutes	-1%	Result in a 1% deduction from the total Mission 3 scores for each minute passed
2	Causing any kind of damages to the panels	-10%	Result in a 10% deduction from the total Mission 3 scores for any damages to the panels

9.2.4. Mission 4 (Mars Field)

No	Parameter	Step Score	Detailed Explanation
1	Navigating to the point B	5	The location of point B is shared with the teams and there is a circle around point B. To get to point B the rover should be in the circle.
2	Following the footsteps of astronauts to the point C	10	The rover should track visible steps and find the entrance of the lava tube. There is a circle in front of the entrance of the lava tube which is 2 meters in diameter. To get points from this step the rover should be in the circle.
3	Following the footsteps of astronauts from point C to the entrance of the lava tube.	10	The rover should track visible steps and find the entrance of the lava tube. There is a much bigger highlighted area which is 2 meters in diameter. To get points from this step the rover should be in this highlighted area.
4	Entering the lava tube	5	The rover should enter the lava tube without touching the borders of it.
5	Finding the astronauts	15	In the lava tube the rover should find the missing astronauts. There is a circle in front of the astronauts which is 2 meters in diameter. To get points from this step the rover should be in this circle.
6	Taking pictures of astronauts	5	The rover should take pictures of all astronauts and send them back to the Mars base.
7	Exiting the lava tube	10	The rover should exit the lava tube without interfering with the boundaries of the lava tube.
8	Navigating back to the airlock	5	The rover should navigate back to the known location of the airlock.
9	Entering the airlock	5	The rover should enter the airlock so that no part of it is left outside of the airlock.

9.2.5. General Scoring for Missions 1 to 4

1. Intervention
Teams can make a maximum of 3 interventions.
An intervention deducts 15% scores from the mission performed.
Two interventions deduct 40% scores from the mission performed.
Three intervention deducts 70% scores from the mission performed.
Time elapsed during the intervention is deducted from duty time.
Pressing the emergency button is considered an intervention.
In case of a security problem, if the emergency button is pressed, the team is deemed to have intervened. (going out of the field etc.)
2. Skipping
In the event of a skipping, touching the rover will be considered an intervention.
Skipping does not stop the timer, the timer continues to run.