GAR 2027 Space Technology - Lunar Exploration

GAR 2027 - Version A

1. Scope of Competition

1) Competition groups: primary school group (grade 4-6), junior middle school group, senior middle school group (including technical secondary school and vocational high school).
2) Number of participants: 2-3 contestants/team.
3) Coach: 1 person (optional).
4) Each person is limited to participating in 1 event and 1 team.
5) Group determination: based on the level of study of the contestants as determined by the local education administrative department (education committee, education department, education bureau).

2. Competition Theme

Space technology continuously pushes the boundaries of human engineering, driving iterative innovation across various cutting-edge fields; it serves as the fundamental pillar supporting deep-space engineering and the long-term development of the aerospace industry. As the celestial body closest to Earth, the Moon offers a natural, cost-effective, and highly valuable platform for the practical testing and validation of diverse deep-space systems.

Centered on the theme "Space Technology - Lunar Exploration", this robotics competition simulates the complex environments and scientific missions of lunar exploration, focusing on intelligent unmanned reconnaissance and autonomous operations. The event features core challenges such as lunar surface navigation and sampling, paying tribute to the spirit of aerospace through technological innovation and embarking on a new journey of deep-space exploration through ingenuity and practical action.

3. Competition Process

1) Registration. Contestants must register in the prescribed manner and within the specified time frame; successful registration qualifies them to participate in the competition.
2) Competition. Contestants compete within the allotted time, and first, second, and third-place prizes are awarded.

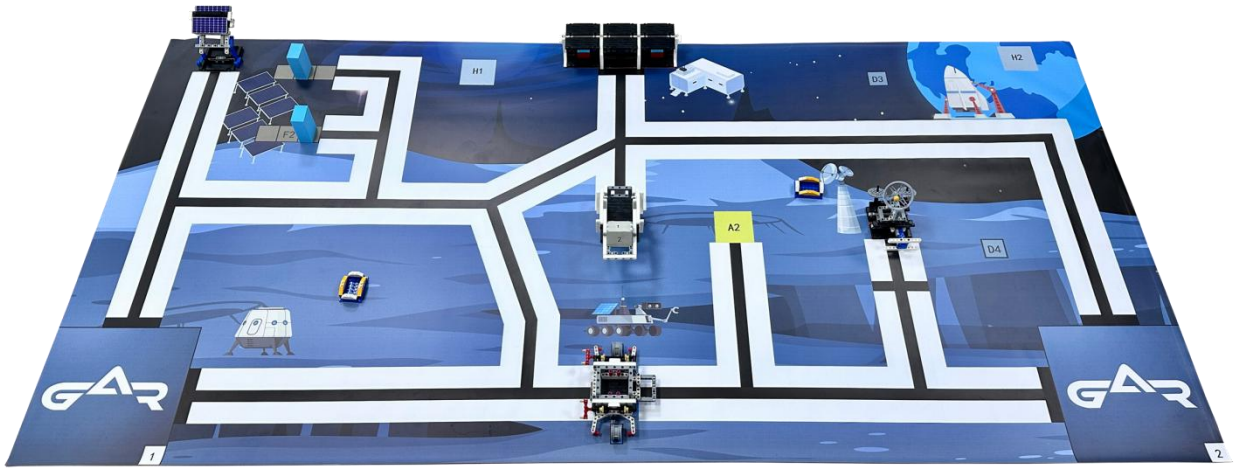
4. Competition Environment

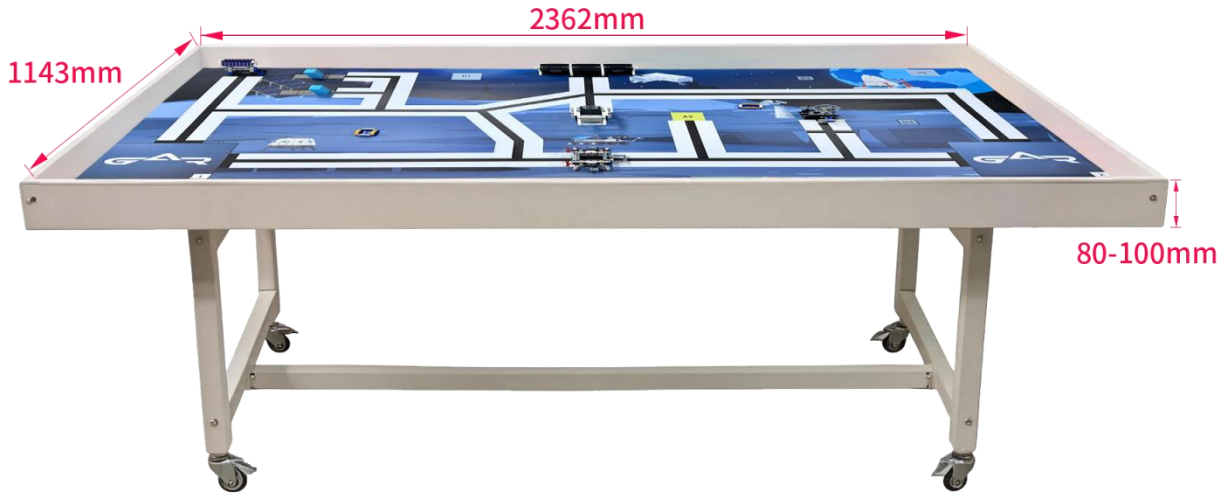
1) Programming system: Use computer programming.

2) Forbidden equipment: USB flash drives, mobile phones, tablets, intercom, etc.

3) Competition venue: The size of the competition map is 2362mm*1143mm.

The map images used in these rules are for illustrative purposes only; the actual dimensions, marked points, and the material, size, and weight of props for the competition map shall be as provided at the venue.

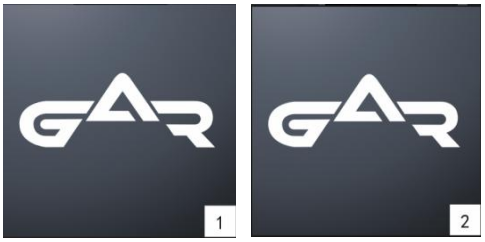




Note: The two sides of the map connected to Base 1 lies flush against the inner edge of the arena platform.

Map

4) Base: There are two bases, each measuring 300mm * 300mm. During the competition, participating teams may stay within the base to adjust their equipment's structure and programming, or to temporarily store task-related prop modules.



5. Competition Equipment

1) Each team is limited to one robot.

2) Before activation, the robot's maximum dimensions (length, width, and height) must not exceed 30cm x 30cm x 30cm; there are no size restrictions after activation.

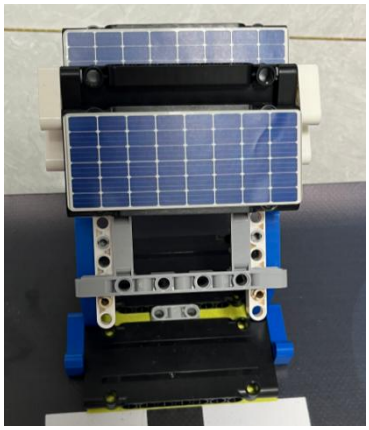
3) Only one controller is permitted. The controller must feature two PH-6PIN bus interfaces and one 3-pin digital servo interface; the total number of ports on a single controller is limited to two motor ports, two servo ports, and no more than five sensor ports.

4) The robot's structure must be built using plastic blocks based on the 8mm construction system.

6. Competition Tasks

Task One: Energy Station Connection and Recharging

Simulating the solar array energy station of the Chang'e-8 mission on the lunar surface, the robot must fully unfold the folded photovoltaic panels on the model.

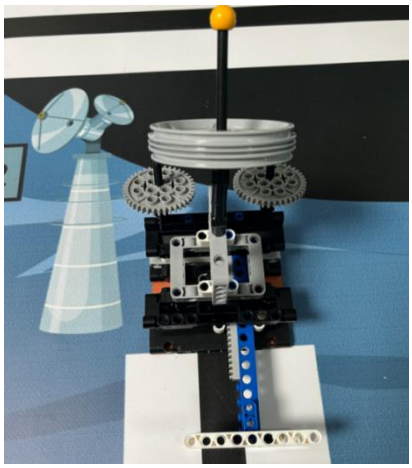
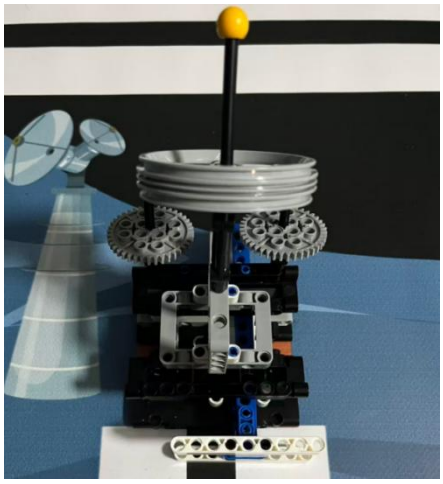
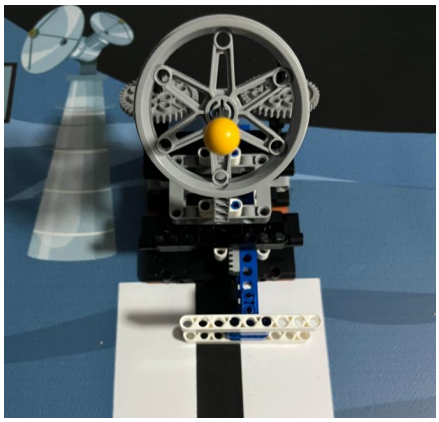
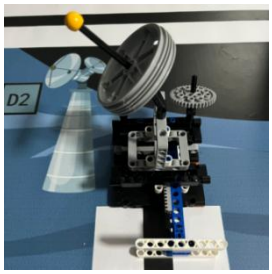
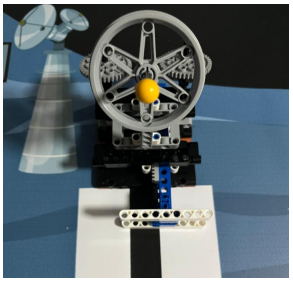
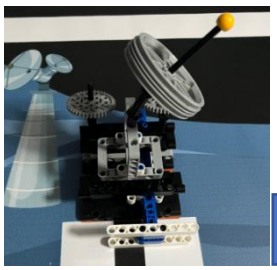
	
Initial Status	Completion Status

Primary School Group (grade 4-6): The model must be secured at position A1. If the robot fully unfolds the photovoltaic panel, it earns 30 points; no points are awarded if the panel is only partially unfolded or remains folded.

Junior Middle School and Senior Middle School Group: The model must be secured at either position A1 or A2 (the specific position will be determined by a draw prior to the debugging phase). If the robot fully unfolds the photovoltaic panel, it earns 30 points; no points are awarded if the panel is only partially unfolded or remains folded.

Task Two: Deployment of Relay Communication Base Stations

The Queqiao-2 relay satellite addresses the communication blind zone on the far side of the Moon; a robotic system operates a base station model to adjust the orientation of the signal antenna.

<table>
<tr><td></td><td></td></tr>
<tr><td>Initial Status</td><td>Completion Status - Primary School Group (G4-6)</td></tr>
<tr><td>
Down</td><td>
Left

Down

Right</td></tr>
<tr><td>Completion Status for Junior Middle School Group</td><td>Completion Status for Senior Middle School Group</td></tr>
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The model is fixed at position B, with its initial orientation as shown in the image above.

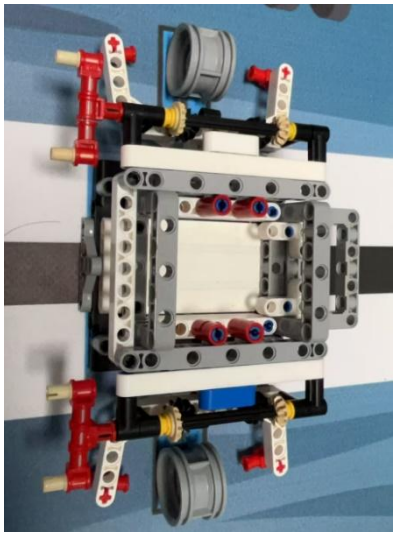
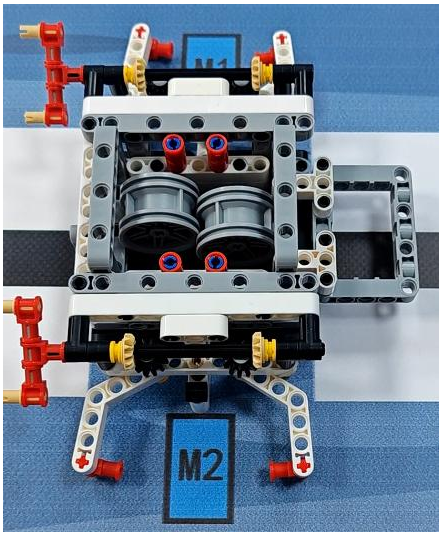
Primary School Group (grade 4-6): If the robot pushes the transmission mechanism to rotate the signal device at least one full revolution and maintains this state until the end of the round, it earns 30 points.

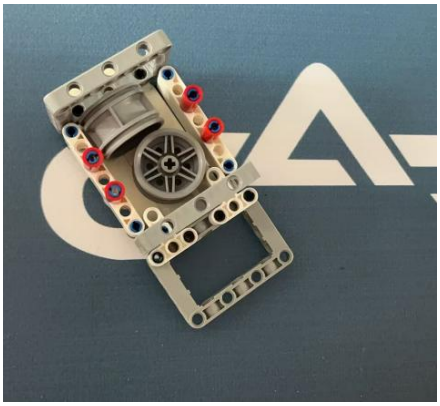
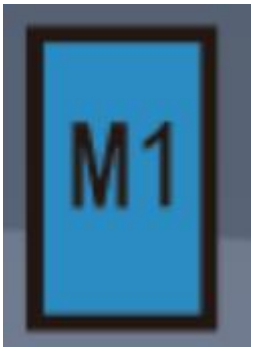
Junior Middle School Group: If the robot pushes the transmission mechanism to rotate the signal device by approximately 180°—such that the vertical projection of the yellow ball at the top of the signal device falls entirely within the area defined by the black line and the adjacent white zone—and maintains this state until the end of the round, it earns 30 points. The final interpretation rests with the referees, who will determine the score based on the specific circumstances.

Senior Middle School Group: The orientation of the signal device is determined by a draw prior to the setup phase (choosing from three possible directions within zone B). If the robot pushes the transmission mechanism to rotate the signal device toward the side selected in the draw—such that the vertical projection of the yellow ball at the top of the signal device falls within the designated sector area in zone B—and maintains this state until the end of the round, it earns 30 points. The final interpretation rests with the referees, who will determine the score based on the specific circumstances.

Task Three: Multi-Point Stratified Lunar Soil Sampling

To simulate the sampling of lunar soil samples at different depths by Chang'e 6, the robot needs to collect the lunar soil model into the receiving frame and bring it back to the base.

	
Initial Status	Status of Lunar Soil Collection Completion

		
Status of Lunar Soil Transport Completion	Initial Placement Area for the Lunar Soil Model	

As shown in the figure above, the model is secured in Zone C, with its retrieval mechanism oriented toward Base 1. Lunar soil models are placed in Zone M1 (surface soil) and Zone M2 (subsurface soil).

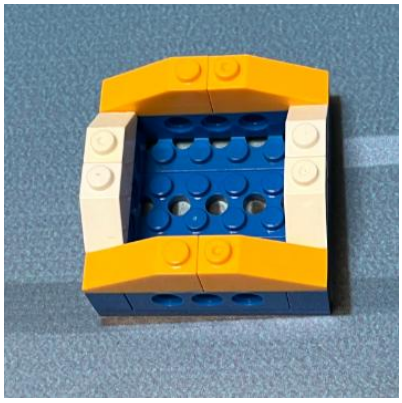
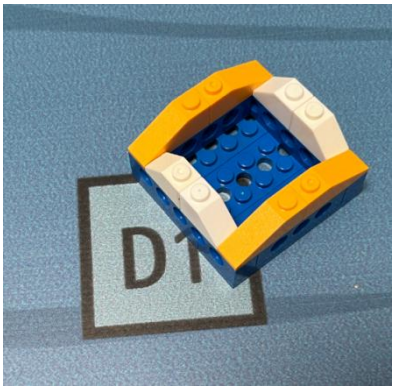
Primary School Group (grade 4-6): Trigger the retrieval mechanism to collect any lunar soil model and place it into the collection container to earn 20 points (maximum 20 points). Subsequently, return the collection container to any one base; if the container holds at least one lunar soil model and its vertical projection makes contact with any base, an additional 20 points are awarded.

Junior Middle School Group: A draw will be held before the trial to determine which type of lunar soil must be collected. Retrieve the specified soil model and place it into the collection container to earn 20 points (maximum 20 points). Subsequently, return the collection container to any one base; if the container holds at least one lunar soil model and its vertical projection makes contact with any base, an additional 20 points are awarded. If the wrong lunar soil model is collected, or if both lunar soil models are collected, no points will be awarded for any part of this task.

Senior Middle School Group: Collect both surface and subsurface lunar soil models and place them into the collection container. Each successfully retrieved soil model earns 10 points (maximum 20 points). Subsequently, return the collection container to any one base; if the container holds lunar soil models and its vertical projection makes contact with any base, points are awarded based on the number of models inside—10 points per model, up to a maximum of 20 points.

Task Four: Crater Obstacle Avoidance

Simulating the complex, rugged, and cratered terrain of the Moon, the robot must autonomously navigate around the crater models while in operation.

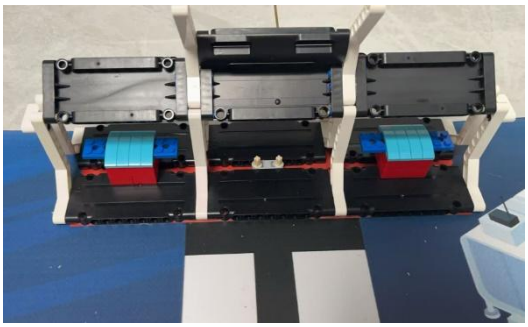
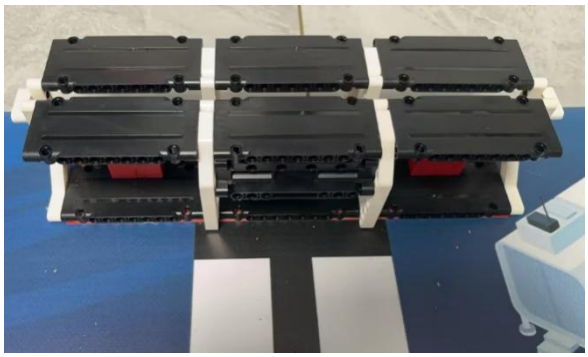
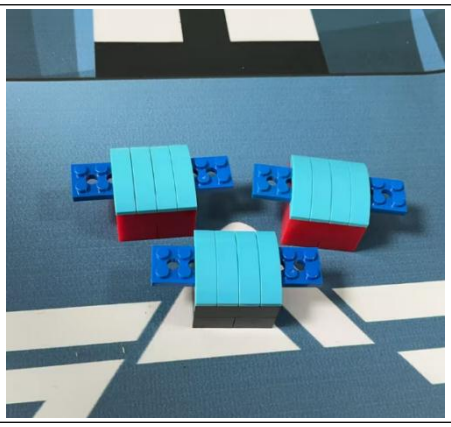
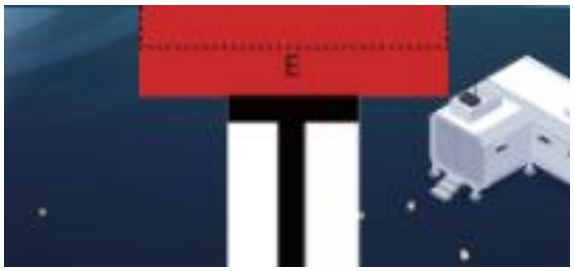
	
Initial Status	Failure Status

Primary School Group (grade 4-6): There is one crater model, placed randomly in one of the positions D1–D4 (determined by a draw before the debugging phase). If the robot travels autonomously from Base 1 to Base 2—ensuring its vertical projection remains within the black line and it does not make contact with the crater model—it earns 20 points. During the execution of other tasks, 5 points are deducted for each instance of contact with the crater model, up to a maximum deduction of 10 points.

Junior Middle School and Senior Middle School Group: There are two crater models, placed randomly in two of the positions D1–D4 (determined by a draw before the debugging phase). If the robot travels autonomously from Base 1 to Base 2—ensuring its vertical projection remains within the black line and it does not make contact with the crater models—it earns 20 points. During the execution of other tasks, 5 points are deducted for each instance of contact with a crater model, up to a maximum deduction of 10 points.

Task Five: In-Situ Resource Utilization (ISRU) on the Moon

Benchmarked against the Chang'e-8 mission—which validates the use of local lunar materials—the robot will transport processed materials to the base.

	
Initial Status for Primary School Group (Grade 4-6)	Initial Status for Junior Middle School and Senior Middle School Group
	
Completion Status	Model Fixed Area

The objects are placed within the dashed-line box in Zone E. There are three objects in total: two red and one black, with the black one positioned in the middle.

Primary School Group (grade 4-6): The hatch is open at the start. The robot must retrieve an object and transport it to any base. An object is considered successfully delivered if its vertical projection makes contact with a base. Each red object is worth 15 points, and the black object is worth 30 points, for a maximum possible score of 60 points.

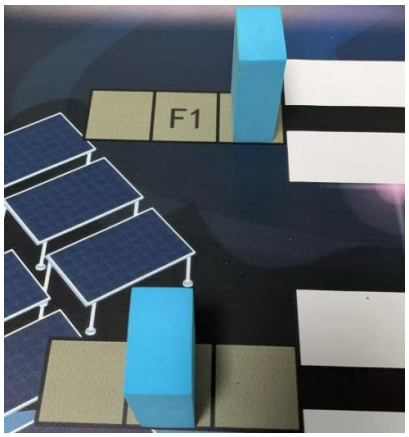
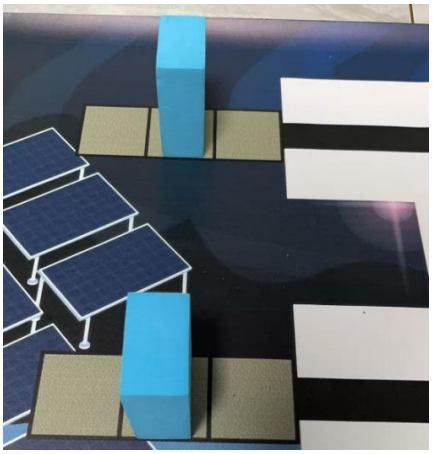
Junior Middle School Group: The hatch is closed at the start. The robot must first open the hatch, then transport an object to any base. An object is considered successfully delivered if its vertical projection makes contact with a base. Each red object is worth 15 points, and the black object is worth 30 points, for a maximum possible score of 60 points.

Senior Middle School Group: The hatch is closed at the start. The robot must first open the hatch, then transport an object to a designated base (the specific base will be determined by a draw prior to the

debugging phase). An object is considered successfully delivered if its vertical projection makes contact with a base. Each red object is worth 15 points, and the black object is worth 30 points, for a maximum possible score of 60 points.

Task Six: Exploration of Water Ice in Permanently Shadowed Regions

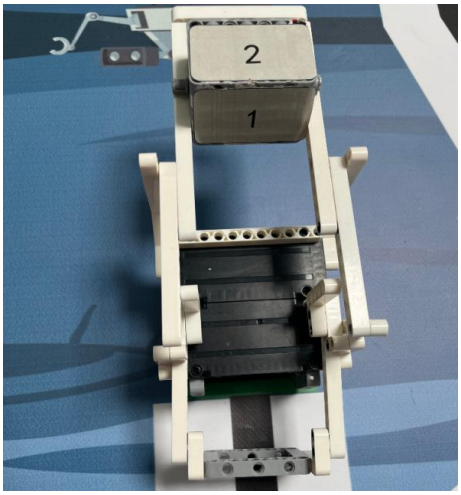
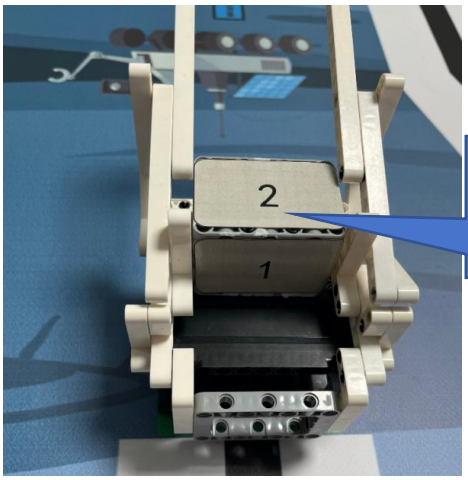
Simulating the search for water ice within the permanently shadowed regions at the lunar south pole, as part of the Chang'e-7 mission.

	
Initial Status	Completion Status

A model representing "suspected water ice" (made of an EVA foam block) is placed in each of the F1 and F2 zones; the specific locations are determined by a random draw conducted by the judges before the debugging phase. The robot must autonomously explore these two zones using infrared sensors to identify which model is closer to the black line. It must then display this result on its screen (for example, if the model in zone F1 is closer to the black line, the screen should display "F1"). If the correct result is displayed and remains visible until the end of the match, 20 points are awarded. Subsequently, the robot must move one of the models into the same zone as the other (e.g., having both models end up in the same zone—such as the one between F1 and F2—constitutes success). Only one model may be moved. If the model is placed correctly (upright and not toppled) and remains in that position until the end of the round, an additional 20 points are awarded. (The zone in which a model is considered to be located is determined by which zone contains the largest portion of the model's vertical projection; the judges hold the final authority on this determination and will award points based on their assessment of the situation.)

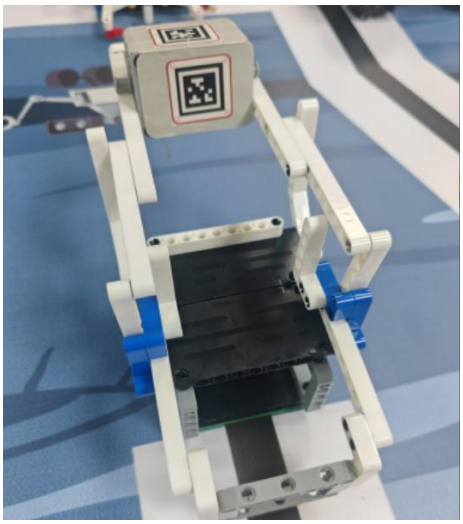
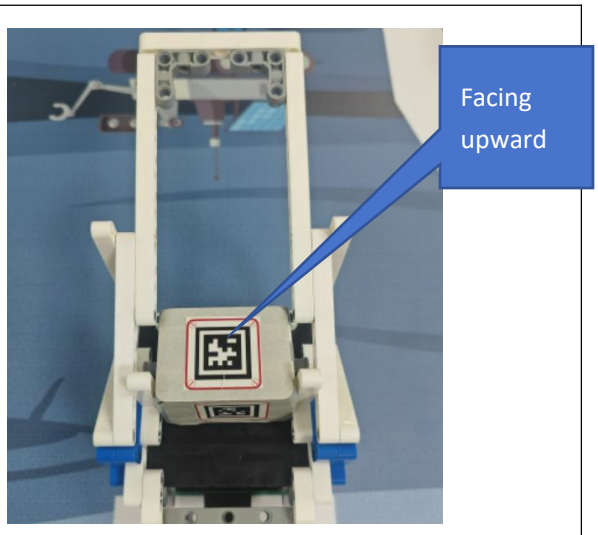
Task Seven: Return to Base

Upon completing all tasks, the robot comes to a final stop at the base, with its vertical projection falling entirely within the base area.

	
Initial Status	Completion Status

Primary School Group (grade 4-6): At the end of a round, the robot must return to any base such that its vertical projection lies entirely within the base area; this earns 30 points.

Junior Middle School Group: The robot must first trigger a random model, causing a task card to be released. The side facing upward upon the card's landing determines whether the robot must return to Base 1 or Base 2. Successfully triggering the model so that the task card drops onto the designated platform earns 10 points; subsequently, if the robot returns to the specified base with its vertical projection lying entirely within the base area, it earns an additional 20 points.

	
Initial Status	Completion Status

Senior Middle School Group: The robot must first trigger the random model to release a task card onto the mechanism platform; successfully triggering the model and causing the task card to drop earns 10 points. The robot must then identify the upward-facing TAG code, display the corresponding identification result on a screen, and return to the designated base associated with the identified TAG code (e.g., if the identified TAG code corresponds to number 1, the robot returns to Base 1; if it corresponds to number 2, it returns to Base 2). If the robot's vertical projection remains entirely within the base, and the entire sequence—from triggering the random model to returning to the designated base—is completed as a continuous, uninterrupted process (without any human contact with the robot or interruption to the program execution), an additional 20 points are awarded.

Challenge Tasks:

There are 2 challenge tasks in total. The task models and scoring requirements will be announced prior to the on-site debugging phase.

7. Variable Summary:

All variables (with the exception of those for randomized task models) are determined by a draw conducted by the judges before the debugging phase begins.

1) **Energy Station Connection and Recharging:** For the **Junior and Senior Middle School Groups**, the model's position is determined by a draw between locations A1 and A2.
2) **Deployment of Relay Communication Base Stations:** For the **Senior Middle School Group**, the orientation of the task-completion signal indicator (facing "left," "right," or "down" toward Zone B) is determined by a draw.
3) **Multi-Point Stratified Lunar Soil Sampling:** For the **Junior Middle School Group**, the type of lunar soil model to be collected—surface lunar soil or subsurface lunar soil—is determined by a draw.
4) **Crater Obstacle Avoidance:** For the **Primary School Group (grade 4-6)**, one position is selected from D1–D4 via a draw; for the **Junior and Senior Middle School Groups**, two positions are selected from D1–D4 via a draw.

5) **In-Situ Resource Utilization (ISRU) on the Moon:** For the **Senior Middle School Group**, the base (Base 1 or Base 2) to which the model must be transported is determined by a draw.

6) **Exploration of Water Ice in Permanently Shadowed Regions:** The placement of water-ice models at locations F1 and F2 is determined by a draw.

8. Time and Frequency

Group	On-site Programming and Debugging Time	Task Duration	Task Frequency
Primary School Group (grade 4-6)	Confirmed by the on-site judge team	180s/times	2 times
Junior Middle School Group		180s/times	2 times
Senior Middle School Group		180s/times	2 times
1. On-site programming and debugging time: During this time, all participating teams in each group will perform programming and debugging uniformly. 2. Specified task time: The start and end time specified by the robot to complete the competition. If the competition is not completed within the specified time, the competition will be forced to end.			

9. Operation and End

9.1 Robot Operation

1) Robot Start-up and Operation: Robots must remain stationary before starting from the base. Initiating the robot by "pressing a button" is permitted; once started, the robot must operate autonomously.

2) No pauses are permitted within the time limit allotted for completing the task.

3) If any structural components detach from a robot during the allotted task time, the participants may retrieve the detached parts—provided that the robot's continued operation is not compromised—and continue using them.

4) Robots may not be replaced during a match (though functional structural components required for specific tasks may be swapped out). Modifications to a robot's structure or programming are permitted only while the robot is in the base.

5) The order in which participants compete will be determined by the judges on-site.

9.2 Restart

Restart: This refers to the act of manually returning a robot to its base during a match. There is no limit to the number of restarts allowed within a single match. At the start of each match, a "restart bonus" of 20 points is awarded; each restart results in a deduction of 5 points from this bonus. Restarts may continue even after the bonus points have been fully depleted, with no further point deductions. Points earned for tasks completed prior to a restart remain valid. If a task has not yet been scored but the task model has been moved from its initial state, it may not be manually restored to its original position.

9.3 End of Competition

1) Complete all tasks within the allotted time.
2) The allotted time has ended.

10. Evaluation Criteria

10.1 Score Calculation

1) If only a portion of the task is completed within the allotted time, the score will be calculated based on the actual number of tasks completed.
2) The sum of the two scores will be taken.
3) The higher score will be ranked higher. If scores are tied, the shorter time will be ranked higher. If both scores and time are tied, the shorter number of restarts will be ranked higher. If all three are tied, the teams will be ranked tied.

10.2 No Awards

1) The contestant arrives more than 10 minutes late.
2) The contestant intentionally damages the competition venue.
3) The contestant fails to follow the instructions of the referee (or judges).
4) The contestant is absent from the competition.
5) The contestant receives a score of zero.
6) A complaint is filed against the contestant and is subsequently upheld.
7) The contestant participates in multiple competition categories.
8) The robot is operated via manual remote control after it has been started.

11. Related Notes

1) Each contestant is limited to participating in only one competition category. Duplicate or fraudulent registrations are strictly prohibited; any such instances discovered or reported will result in disqualification.
2) Contestants may form teams with students from the same institution or with students from other institutions within the same prefecture-level city. Forming teams across provincial or prefecture-level city boundaries is not permitted; any such instances discovered or reported will result in disqualification.
3) These rules serve as the basis for officiating. Judges have the final authority on all decisions during the competition. Any matters not covered by these rules shall be determined by the panel of judges.

GAR 2027 Space Technology - Lunar Exploration Competition Score Sheet

GAR 2027 - Version A

Primary School Group (Grade 4-6), Junior Middle School Group, Senior Middle School Group

Name: Contestant 1: Contestant 2: Contestant 3:			Group: Primary School Group (4-6) □ Junior Middle Group □ Senior Middle Group □	
	Tasks	Score	Round 1 Scoring	Round 2 Scoring
1	Energy Station Connection and Recharging	30		
2	Deployment of Relay Communication Base Stations	30		
3	Multi-Point Stratified Lunar Soil Sampling	40		
4	Crater Obstacle Avoidance	20 (minus 5 scores/times)		
5	In-Situ Resource Utilization (ISRU) on the Moon	60		
6	Exploration of Water Ice in Permanently Shadowed Regions	40		
7	Return to Base	30		
8	Challenge Task 1			
9	Challenge Task 2			
	Restart times in single round Minus 5 scores per time	20	Times:_____ Scores: -_____	Times:_____ Scores: -_____
	Time	180s	_____min_____s	_____min_____s
	Total Score (max. 270 scores, not including challenge tasks' scores)			
Team Signature			**Judge Signature**	