The responses are based on the Lunabotics 2024 Guidebook. The Guidebook and the FAQ's are to be read as one document.

(FAQ's) 4.0 - 05.07.2024 (FAQ 42 – 43)

Q43: How can we see our robots run at KSC? A43: Please use the following link:

The following is the Livestream link KSC May 16-17, 2024: https://nasa.6connex.com/event/DiscoverNASA/NASALunaboticsChallenge/login

For complete information about Lunabotics go to: https://www.nasa.gov/learning-resources/lunabotics-challenge/

NASA Artemis Student Challenge Team Reacts to Lunabotics Test Run: <u>https://www.youtube.com/watch?v=x7A8B9UbYm4</u>

Q42: The Caterpillar Autonomy Awards will be based on summation of the autonomy points at both UCF's Exolith Lab arenas and at KSC's Artemis Arena. You will be updated on-site at both events. The Caterpillar Autonomy Award will be presented at the Lunabotics Award Ceremony at KSC. **A42: NA**

(FAQ's) 3.0 - 05.05.2024 (FAQ 33 - 41)

Q41: How do we get access to the on-site at KSC?

A41: Your Faculty Advisor of record and team lead of record will receive an email message with a PDF copy of the KSCVC Parking Pass and the schedule for the week of May 15 -17, 2024. They will be responsible for sending each member of their team the PDF copy of the KSCVC Parking Pass and the schedule of the week.

Print a Parking Pass for each vehicle /present the PDF pass on your phone/device.

- 1. Wednesday May 15, 2024, 1100 am 12 noon Present your parking pass so the KSCVC parking attendant can see it easily.
- 2. For driving directions Google The Center for Space Education, Kennedy Space Center, M6-306 405 State Road, Kennedy Space Center, FL 32899.
- **3**. Show your Parking Pass, then go to Lot 4 and park your vehicle there. There will be Lunabotics Staff at the front of Lot 4.
- 4. Show your ID, and it will be matched to a list of names. If your name is not on the list, there will be a delay as we will process the lists first.
- 5. Once you have been identified, you will be provided a lanyard/badge and a KSCVC Entrance Ticket.

- 6. Keep the KSVC Parking Pass and KSVC Entrance Ticket throughout your stay. You will need it to enter the Complex every day.
- 7. All will enter through the KSCVC Main Entrance (show your KSCVC Entrance Ticket) and proceed through the Rocket Garden to the Center for Space Education Building (M6-306), located on the west side of the garden.
- 8. Procced into the building to the RoboPits, see the map in the Guidebook, attached.
- 9. Thursday May 16, 2024, 0700 am 0830 am there will be Lunabotics Staff at the front of Lot 4.
- 10. Show your ID, and it will be matched to a list of names. If your name is not on the list, there will be a delay as we will process the lists first.
- 11. Once you have been identified, you will be provided a lanyard/badge and a KSCVC Entrance Ticket.
- 12. The Complex entrance will be open for VIP/staff/volunteer and the top ten teams. All will enter through the KSCVC Main Entrance (show your KSCVC Entrance Ticket) and proceed through the Rocket Garden to the Center for Space Education Building (M6-306), located on the west side of the garden.
- 13. Friday May 17, 2024, 0900 am the Complex entrance will be open for Lunabotics student/faculty guests. All will enter through the KSCVC Main Entrance (show your KSCVC Entrance Ticket) and proceed through the Rocket Garden to the Center for Space Education Building (M6-306), located on the west side of the garden.

Q40: I have a question regarding the sling system attachment points that the robot needs. Section 6 states that "Robots shall have a central hoist point or sling system based around the robot's center of gravity (CG). The hoist point or sling system will allow the robot to be picked up by an overhead crane for placement into an arena." Does a sling that goes through all 4 wheels suffice to meet this requirement? I've attached some pictures of the robot and wheels for reference.

A40: The key principle is "sling system based around the robot's center of gravity (CG)". If the team can show during the Lunabot inspection that the sling system cannot shift or slide through the wheels and that it will prevent unintended tipping of the bot then it will be acceptable.

Q39: I am emailing regarding a passage in the guidebook referring to a central hoist. Is this hoist used exclusively to place the robot in the pit or is it used as an option if the robot is too heavy to lift by hand? I am asking as our robot is relatively light weight and I wanted to know if the hoist was optional so we could further shed some more weight by not having it.

A39: Without a rule, rubric or paragraph to refer, the answer is yes. Yes, it is required.

Q38: We have several questions about navigational beacon placement that are not addressed in the rules, see Navigational protocol – page 51 and Robotic Operations – page 34. From the above references in the rules, no information is given regarding beacon size, the arena frame structure to which it attaches, etc. Is it possible to get photos/diagrams of this part of the arena walls with dimensions? For example, isn't there a pipe associated with the ventilation system of the arena that runs along the inside wall around the arena? Does this pipe interfere with placement of a beacon on the inside walls? See figure below. **38A: See below:**



FAQ 38-1/3



FAQ 38-2/3



2 x 80/20 Aluminum Beams (2m length each) https://www.8020.net/ Note: Attached flush with the top of the wooden box walls

Beacons or fiducial targets may be attached to the designated arena frame area for navigation purposes only. The designated area is anywhere on the bin frame structure along the perimeter of the starting zone (2 sides). Tape, clamps, or rods pushed into the regolith may be used, but screws or other fasteners requiring holes may not be used. This navigational aid system must be attached during the setup time and removed afterwards during the removal time.

FAQ 38-3/3

Q37: Can we ship our robots to or from KSC?

A37: The team is responsible for bringing or shipping their robots and gear to the challenges. NASA, The Astronauts Memorial Foundation (AMF), assume no liability in this action. Deliveries and pick-ups will be made inside of the facility. It is the team's responsibility to use a reputable agent that has the resources to load and unload the container to/from the shipping vehicle and bring them into the facility. Containers left on-site will be disposed the following Thursday after the competition has ended.

Shipping to the Competition at KSC: The Astronauts Memorial Foundation (AMF) Center for Space Education Building (CSE) Mail Code AMF, State Road 405 Building M6-306 Kennedy Space Center, FL 32899 Hours: 9 A.M. – 3 P.M. local time

Q36: How long will our robot remain in the arena once it has stopped moving?

A36: At the discretion of either the Mining Judge or the Mission Control Judge, after the end of the 4th minute (at the 5 minute mark) if the robot does not move or ceases to move for a period of 5 minutes, then the Emergency Power Off (kill switch) will be activated. The robot will be removed from the arena and returned to the team for further action.

Q35: Would you be able to send me an example of the metal vented battery box that is required for charging? The team has been using a standard explosion-proof bag link the one linked here. I am

assuming this would not be acceptable for our battery box container during the competition due to the guidelines.

A35: The battery protocol is updated to read as follows:

13. Battery Protocol - Lithium-Ion / Nic-Cad batteries used in your robots.

1. Batteries must be attended while charging. Chargers shall be unplugged overnight.

2. Battery containers must be designed for safely storing, charging and transporting lithium-ion batteries, or approved equivalent.

3. Batteries must be stored in upright containers; batteries cannot be in contact with each other.

4. Batteries that have been dropped must be inspected for damage and replaced as needed.

5. Do not store batteries that are hot to the touch after charging.

6. If a battery continues to feel hot after charging, if possible, remove from the building and place outside and notify NASA Fire as a non-emergency issue.

7. Items 5 and 6 are judgement calls, no one will fault you if in your opinion you need to call KSC Fire at 321.867.7911.

Q34: If we are not a part of the 10 teams that make it to KSC, do we still need to check in with our faculty advisor to get our passes to spectate the competition, or are we able to do so without our faculty advisor? If we do need our advisor to check in for this, is our advisor able to leave after check in? A34: If you are not part of the 10 teams that make it to KSC, you do not need your faculty advisor with you to come to KSC. But you still need to submit a list of potential attendees to reserve tickets and get parking passes. Please submit, your school's name, students last name, first name and M.I. by 5PM eastern time, Wed April 24, 2024.

Q33: If we are spectating the competition, are there any restrictions on where we can and cannot go (e.g. are we allowed in the pits to see the other teams and can we still see the arena)? A33: You will be able to go where the other competitors can go. You can attend the various seminars being offered, see the robots run, visit the Kennedy Space Center Visitor Complex, etc. See the attached schedule:

	Lunabotics 2024 Free	uently	Asked Questions	(FAQ) 1.0	, 2.0,	3.0,	4.0
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Lunabotics 2024 Kennedy Space Center On-Site Schedule May 15 - 17, 2024 (dates and times are subject to change)								
Date	Wed May 15, 2024			Thu May 16, 2024			Fri May 17, 2024	
Time	Check-In Day	Events		Day 1	Events		Day 2	Events
7:00 AM				RoboPi	ts Open		RoboPi	ts Open
8:00 AM				Judges	Meeting		Judges	Meeting
8:15 AM								
8:30 AM								
8:45 AM								
9:00 AM							Berm Build 1	CAT Team Talk
9:15 AM				Opening	Ceremony			
9:30 AM								CAT Team Talk
9:45 AM							Berm Build 2	
10:00 AM				Berm Build 1	Jonette Stecklein,			CAT Team Talk
10:15 AM					JSC - How to			
10:30 AM					Lunabotics SE		Berm Build 3	CAT Team Talk
10:45 AM				Berm Build 2	Paper (and How to			
11:00 AM	Team Check-In				Win the Whole			CAT Team Talk
11:15 AM					competition		Berm Build 4	
11:30 AM				Berm Build 3	CAT Team Talk			CAT Team Talk
11:45 AM								
12:00 PM	Prep Robots	LUNCH						CAT Team Talk
12:15 PM	Safety			LUNCH	Dr. Dan Britt - UCF		LUNCH	
12:30 PM	Communications				Exolith Lab - "Simulating			CAT Team Talk
12:45 PM	Inspection	IPEx Overview and			Planetary			
1:00 PM	Tour KSCVC.	RASSOR Demo			Surfaces"			CAT Team Talk
1:15 PM		Streamed to		Berm Build 4	CAT Team Talk		Berm Build 5	
1:30 PM		RODOPIt Screens						CAT Team Talk
1:45 PM					Phil Metzger, PhD.,			
2:00 PM		Joey Palmowski,		Berm Build 5	UCF -		Berm Build 6	Monica Davila -
2:15 PM		Honeybee			the Solar System			NASA Internships
2:30 PM		"Redwater – Mars			Economy"			
2:45 PM		Water Extraction		Berm Build 6			Berm Build 7	CAT Team Talk
3:00 PM		System"						
3:15 PM					CAT Team Talk			CAT Team Talk
3:30 PM		3D Scanning - Tan		Berm Build 7			Berm Build 8	
3:45 PM		Nguyen, RIEGL			Hetal Miranda -			CAT Team Talk
4:00 PM		Binni, Allen &			Tech Transfer			
4:15 PM		Company		Berm Build 8	Jonette Stecklein,		Berm Build 9	CAT Team Talk
4:30 PM					JSC - Systems			
4:45 PM					the Systems			
5:00 PM				Berm Build 9	Engineering Tools		Berm Build 10	
5:15 PM					Work Together			
5:30 PM					CAT Team Talk			
5:45 PM				Berm Build 10			Award C	eremony
6:00 PM	RoboPi	ts Close			CAT Team Talk			
6:15 PM								
6:30 PM				RoboPi	ts Close			

(FAQ'S) 3.0

GUIDEBOOK CHANGES - 01.25.2024

- 1. Section 8.1 LUNAR SITE PREPARATION & BULK REGOLITH BERM CONSTRUCTION CATEGORY
- The last sentence is changed to read as follows; "Teams not winning first, second or third place in the construction category can still earn one bonus point for each <u>0.2</u> cubic meters of berm constructed up to a maximum average of ten points."



- 3. Section 8.2 SCORING
- 4. Item 2. Berm Construction, Example Construction Points, is changed to read as follows; "150.00".

Construction Points Calculator – Artemis Arena								
Construction Category Elements	Units	Specific Points	Example Actuals	Example Construction Points				
1. Pass All Inspections (Comm/Vehicle).	1,000=Pass / 0=Fail	0 or 1,000	1,000.00	1000.00				
2. Berm Construction – A volumetric scan before and after the run will be performed. Only the berm volume within the target berm location will be counted. The team will earn 2500 construction points for each cubic meter of berm constructed above grade.	cubic meters m^3	2500	0.06	<u>150.00</u>				

Q31: Are touch sensors referred to in 6.1.6 banned all together or just for collision avoidance purposes? For example, if we wanted to put a load cell or other touch sensor on the end of a shovel on the robot for the purpose of knowing when the shovel has hit the ground, would this be

banned (6.1.6: The robot can run either by telerobotic (remote control) or in autonomous operations and cannot have any touch sensors to sense and avoid obstacles)). **A31: Touch sensors are not permitted.** (NYU)

Q30: What are the communication distance requirements for the wireless access point? A30: The Wireless Access Point (WAP) must be able to communicate with their construction robot through the Artemis Arena. (UM)

Q29 : Would it be possible to add a custom-made button addition to a COTS kill switch to satisfy the 40mm requirements, as the one we have currently does not fit the 40mm requirement? **A29: No. See Section 10.1.6. (UM)**

Q28: Are the berm structures expected to be an oval, creating a wall with the berm leaving the middle empty, or one large berm structure in the construction zone? A28: That is a determination for the team to make.

(UM)

Q27. Are there any height or width requirements for the berm structure?

A27: See Section 8 and the FAQ's.

Q26: What are the eligibility requirements for an exchange student that will be leaving after the end of this semester?

A26: See Section 3.

Q25 - Is dozing (i.e. pushing a pile of dirt/rocks) with a bladed dozier-type of rover considered an acceptable excavation technique for the competition? In this case, the robot would push material into the berm area to create the berm.

A25: Bulldozing (i.e. pushing a pile of dirt/rocks) with a bladed dozier-type of rover is considered an acceptable excavation and regolith simulant transfer technique for the Lunabotics challenge. In this case, the robot would push material into the berm area to create the berm. All regolith simulant material must be pushed in a pile from the excavation zone into and through the construction zone to the berm. Regolith simulant may be skimmed from the construction zone but only if it is part of the operation of pushing it from the excavation zone into the berm. The bulldozing pushing operation shall not start inside the construction zone – each bulldozing attempt shall start in the excavation zone. (Var)

Q24 - IN THE RMC FAQ, A3 STATES "YES, THE CENTRAL HOIST POINT AND THE FOUR LIFTING POINTS CAN BE DETACHABLE OR MOVABLE". WITH THIS IN MIND, IS THE CENTRAL HOIST POINT ABLE TO BE DETACHED BY HUMANS PRIOR TO THE RUN, OR IS THE ROBOT REQUIRED TO DETACH FROM THE HOIST POINT BY ITSELF DURING THE COMPETITION RUN. A24 – Detached by any sentient being is allowed.

(Tem)

(FAQ'S) 2.0

(FAQ's) 1.0 - 09.08.2023 (FAQ 1–23)

Q1 - Section 4.1.1 - The envelope height limit given is 0.75 m, and the rules say the robot cannot extend 1.5 m beyond it, totaling 2.25 m, but it also says that would be 2.5 m above the regolith. How do we interpret this height limit? Does the extension apply to the envelope height or does it apply to the actual robot height (e.g. Robot height of 0.65 m = deployable height of 2.15 m)? A1 - Robot(s) shall be contained within a payload envelope measuring 1.50 m length x 0.75 m width x 0.75 m height with a maximum mass of 80kg. It may deploy or expand beyond the envelop after the start of each attempt but may not exceed 1.75 m in additional height which is 2.5 m above the surface of the regolith (dimensions correspond to the typical payload volume available on today's Lunar landers that are commercially available). (Pur)

Q2 - Section 4.1.1 & 6.3 - The figure in section 6.3 provides dimensions of 1.5 m x 0.75 m x 0.75 m, while the requirements in section 4.1.1 state that the dimensions should be 1 m x 0.75 m x 0.75 m. What is the correct dimensional constraint?

A2 – See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 6.1 and Section 10.1.4.1. The correct dimension is $(1.5 \text{ m x } 0.75 \text{ m } \times 0.75 \text{ m})$. (Pur)

Q3 - Section 4.1.2 - Can the central hoist point and the four lifting points be detachable or movable? If they can be detachable, do they count toward the mass limit?

A3 – Yes, the central hoist point and the four lifting points can be detachable or movable. They do not count towards the mass limit. They are considered Ground Support Equipment (GSE). (Pur)

Q4 - Section 4.1.10 - The team may decide to use battery cell monitoring leads to read voltage for an under-voltage protection circuit. This, theoretically, would not have its power cut with the emergency stop button. Would this be allowed under the current rules?

A4 - See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 10.1.6 "Only onboard laptop computers and data-logger(s) may stay powered on if powered by its own, independent, internal computer battery. For example: it is acceptable to have a small battery onboard that only powers a Raspberry Pi control computer, and whose power does not flow through the main robot kill switch." Yes, this would be allowed, as long as it is not connected to the main power battery.

(Pur)

Q5 - Section 4.2.5 - What constitutes a far-reaching mechanism? Is there a maximum reach for any component?

A5 - See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 6.2.5. There are too many permutations, tell us your proposal and why you think it may be in conflict with Section 6.2.5. We can move forward from there. The intent of the rule is to prevent a Lunabot from parking and deploying long arms while never moving. The Lunabot must move and be self-supporting. (Var)

Q6 - Section 4.2.6 - Does the beacon/target weight limit not apply in any situation since it refers to the attachment to a sieve, which does not exist in the current competition format?

A6 – See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 6.2.6. Section 6.2.8: "The mass of the navigational aid system is included in the maximum mining robot mass limit of and must be self-powered" (Pur)

Q7 - Section 5.9 & 6.3 - The figure in section 6.3 provides craters of diameter 0.5 m, but the arena specifications in section 5.9 state that craters will be no wider than 40 cm. What are the dimensions we should expect for craters?

A7 - See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 7.6, Section 7.7 and Section 8.3. Crater width = 40-50 cm.

(Pur)

Q8 - Section 6 - Are obstacles allowed to be part of the berm volume? Are prefabricated berm structures allowed to be part of the berm volume?

A8 – See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 8. The obstacles may only be pushed to the side of the arena in the Excavation Zone. There are no obstacles in the Construction Zone. This is an error in the guidebook and will be corrected. Obstacles may be part of the berm volume, but only from the Excavation Zone. Prefabricated berm structures are not allowed to be part of the berm – regolith simulant form the arena must be used.

(Pur)

Q9 - Section 8.2 & 8.3.2 - The score calculator in section 6.2 says the points per cubic meter of berm volume will be 25,000, while section 6.3.2 states the points per cubic meter of berm volume will be 1,000 past 0.026 cubic meters. Which scoring method is accurate? Will there be any points gained for simply hitting the 0.026 cubic meter volume, if that method is used?

A9 – During each competition attempt, the team will earn construction points for each cubic meter of berm constructed above grade. There is no minimum threshold of 0.026 cubic meters.

(Pur)

Q10 - Section 6.4.4 - Will the berm volume be displayed as opposed to mass this year? A10 – Yes, the berm volume will be displayed after it has been scanned and calculated. (Pur)

Q11 - What is the correct volume the 1x.75x.75 outlined in section 4.1.1 or the 1.75x.75x.75 outlined in 8.1.4.2.?

A11 – This has been corrected. See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 6.1 and Section 10.1.4.1. (Pur, UA)

Q12 - What is the correct timeline the one on the website or the one on the rules? A12 - This has been updated. See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 (Var)

Q13 – RESERVED

Q14 - It lists that we must have a hoist point for a crane above the center of gravity on the robot what are the requirements of this?

A14 - See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 6.1.2. Let's think on this. The lifting point is the point at which lifting gear connects with the load it is hoisting. Ensuring that these are securely attached is a critical step in preventing injuries and property damage when using these devices. Please design accordingly, you may have to explain it on your systems engineering paper. (UA)

Q15 - How loose with the material in the excavation zone be (will front loader designs be viable). A15 - Read the Lunabotics 2024 Guidebook – Draft Ver 1.0, dated Sep 01, 2023, Appendix B. Glossary of Terms Item 9. Black Point-1. (UA)

Q16 - Is the minimum berm the .013 m³ in 4.6.1 or the .023 m³ in 3.2

A16 - During each competition attempt, the team will earn construction points for each cubic meter of berm constructed above grade. There is no minimum threshold of 0.026 cubic meters.

(UA)

Q17 - What are the categories for autonomy

A17 - See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 9. Autonomy. (UA)

Q18 - The rules state that there will be BP-1 used at KSC and LHS-1 used at UCF. We just wanted to clarify that this is accurate before we begin designing our bot to the needs of driving on two separate materials.

A18 – It is accurate, please see Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Glossary of Terms, definitions 6 and 10. No issues, this is a good example of applying sound engineering practices and principles. (Tem)

Q19 – RESERVED

Q20 - Lastly, in the rules it states that the orientation of the 3 dimensions of the bots can be decided by the teams as long as it is stated to the judges. It also states in the rules that a height of 1.5m after the bot starts becomes the new maximum height. I wanted to know if this is specific to height only, or if it only pertains to whichever dimension, we dedicate to being our 1.1m length side.

A20 – I can see the confusion, but this is specific to height only. See Lunabotics 2024 Guidebook – Draft Ver 1.0, dtd 09.01.2023 Section 10.4.1. (Tem)

Q21 - The current listed date will affect these teams' ability to compete as well as the ability to travel to Central Florida. Our finals week is May 11th-17th. Would it be possible to push back the in-person competition at least one week to accommodate?

A21 - Read the Lunabotics 2024 Guidebook – Draft Ver 1.0, dated Sep 01, 2023. Per Section 1.9 of our FAQ, we do not honor requests to change dates., "1.9 - Frequently Asked Questions / Ask For Help. There will be no response to requests for information already contained in the Guidebook, to change a date(s), to change/waive a deadline, a rule or a rubric." We understand that the Competition week conflicts with your school's finals, however we can't change the dates for this year's competition for many logistical reasons. Many institutions have policies which allow students to take their finals early or late if they

have to travel for an event related to a school club/team, such as a robotics team participating in a NASA challenge or presenting a paper at an international conference. We encourage you to reach out to your academic institution to see if such policies are available for your team. We are in the process of acquiring feedback to determine the best time for future competitions, however.

(Var)

Q22 - ELIGIBILITY, DELIVERABLES, APPLICATION, Eligibility 3.1.3 - Does this intend to state that both 2 undergraduate students AND ALSO 2 graduate students are needed on a team, or is it a typo and is intended to say "...a minimum of (2) undergraduate students OR graduate students...".

A22 - 3. ELIGIBILITY, DELIVERABLES, APPLICATION, Eligibility 1.3 " The team shall be composed of enrolled undergraduate and graduate students ..." is changed to read "Teams shall: be composed of enrolled undergraduate and graduate students and shall include at least two undergraduate students ..." (Var)

Q23 - What is the policy on international students attending the in-person Lunabotics competition at KSC?

A23 - Non-U.S. Citizens are WELCOME to Lunabotics at the Kennedy Space Center Visitor Complex and the Astronauts Memorial Foundation's Center for Space Education in Bldg. M6-306. Should your team be selected, the student will have to apply through NASA STEM Gateway, like everyone else. Security will make further determinations at that point and advise on the next step in the process.

(Var)

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(FAQ's) 1.0	
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