
SPACE SCIENCE KIT

Lunar Exploration Vehicle — Lesson 05

Enhanced Lesson Plan | Grades 6–8 | Science, Technology, Engineering

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LESSON OVERVIEW

Lesson Title	Design, Build & Program: Lunar Exploration Vehicle — Navigation, Obstacle Avoidance & Mission Tasks
Subject Area	Science, Technology, Engineering (STEM)
Grade Level	Grades 6–8 (Adaptable for 5 and 9)
Duration	3 Class Periods × 45 Minutes (135 minutes total)
Key Themes	LEV Design, Autonomous Navigation, Data Collection, Robotic Attachments, Multi-Mission Programming
Framework	5E Instructional Model (Engage, Explore, Explain, Elaborate, Evaluate)
Builds On	Lesson 04 — The Lunar Lander (full confidence with micro:bit, MakeCode, dual motors, Sonar:bit, and multi-phase programs)

LESSON CONTEXT

What makes Lesson 05 different from Lesson 03 (Lunar Landing Rover)?

- Lesson 03 introduced basic obstacle avoidance using a single forward-facing Sonar:bit and a simple stop-and-turn response.
- Lesson 05 raises the complexity: students build a full Lunar Exploration Vehicle (LEV) with multi-directional navigation, programmable mission tasks (sample collection, waypoint navigation, data logging), and optional robotic attachments.
- Students now integrate everything learned across Lessons 01–04: launch mechanics, mission phases, landing precision, and rover navigation — into one comprehensive autonomous exploration vehicle.
- The simulated lunar environment in Lesson 05 includes multiple mission objectives: navigate to a "sample site," collect a simulated sample, return to base, and avoid all obstacles en route.

SMART LEARNING OBJECTIVES

By the end of this lesson, students will be able to:

#	Objective	Domain

1	Design and build a structurally robust Lunar Exploration Vehicle (LEV) using building blocks that incorporates dual-motor drive, a forward-facing Sonar:bit for obstacle avoidance, and at least one additional feature (e.g., robotic arm, sample collector, antenna).	Design / Engineering
2	Write and upload a MakeCode program that controls the LEV to autonomously navigate a multi-obstacle course, execute at least one programmed mission task (e.g., stop at a sample site for 3 seconds, return to base), and display status on the LED screen.	Programming / Technology
3	Explain the role of lunar exploration vehicles in space science, describe at least three LEV systems (drive, sensing, data collection, power), and connect two engineering or physics principles to their vehicle design and code.	Science / Knowledge
4	Collaborate effectively in a team of 3–4 across all three days, fulfilling a defined role, contributing to all build/code/test phases, and jointly delivering a presentation with a live mission simulation demonstration.	Collaboration / Communication

SUCCESS CRITERIA (I CAN STATEMENTS)

Students will demonstrate success when they can:

- I can sketch and label the key systems of my LEV (drive motors, Sonar:bit, power, mission attachment) before building.
- I can build a stable LEV with aligned wheels, a mounted Sonar:bit, and at least one additional mission feature.
- I can write a MakeCode program that navigates the LEV through a multi-obstacle course and executes a programmed mission task.
- I can explain what a real LEV does, name its key systems, and describe how it contributes to lunar science.
- I can run 3 timed mission simulation trials, record results on a Testing Log, and make at least one targeted improvement between runs.
- I can present my LEV’s design, programming logic, and science connections with a live mission demonstration.
- I can use a "2 Stars & 1 Wish" format to give specific, constructive feedback to another team.

KEY VOCABULARY

Introduce these terms at the start of Day 1 using a word wall, vocabulary cards, or a Quizlet Live activity:

Term	Definition	Real-World Connection

Lunar Exploration Vehicle (LEV)	A wheeled robotic vehicle designed to travel across the lunar surface to conduct scientific investigation and data collection.	Apollo LRV (crewed), Yutu-2 (uncrewed), NASA VIPER (upcoming)
Autonomous Navigation	The ability of a vehicle to plan and follow a path independently using sensor data, without step-by-step human control.	Perseverance on Mars, Yutu-2 on the Moon, self-driving cars on Earth
Mission Task / Waypoint	A specific action or location programmed into a vehicle's mission sequence, such as "stop at sample site" or "return to base."	Real rovers receive mission tasks uplinked from Earth each day
Data Collection	The process of gathering measurements or samples from the environment — the primary scientific purpose of a lunar rover.	Yutu-2 has collected radar and soil composition data since 2019
Robotic Arm / Manipulator	A programmable mechanical arm attached to the rover that can pick up, place, or interact with objects on the surface.	Perseverance's robotic arm drills into Martian rock for samples
Parameter Tuning	Adjusting programmable values (motor speed, sensor threshold, pause duration) to optimise a system's performance.	Engineers tune rover parameters daily based on terrain and battery data
Sonar:bit / Proximity Sensor	An ultrasonic sensor measuring distance to nearby objects, used for obstacle avoidance and navigation decisions.	Real rovers use stereo cameras and LIDAR for the same purpose
Iteration	Repeating the design-test-improve cycle until the system meets its requirements — the foundation of engineering.	NASA engineers iterate rover software updates weekly from Earth

MATERIALS & RESOURCES

Category	Item	Purpose
Hardware	micro:bit v2 (1 per team)	Main programmable controller for all LEV navigation and mission tasks
Hardware	Nezha Breakout Board V2	Connects micro:bit to dual drive motors, Sonar:bit, and any additional actuators
Hardware	PlanetX Smart Motor (2 recommended)	Independent left and right wheel drive for forward movement and turning
Hardware	PlanetX Sonar:bit (ultrasonic sensor)	Forward-facing obstacle detection and proximity measurement
Hardware	USB Cables (1 per team)	Flash programs from computer to micro:bit

Construction	Elecfreaks Bricks Pack (LEGO-compatible blocks)	LEV chassis, wheels, mission attachment (arm, antenna, scoop)
Software	MakeCode (makecode.microbit.org)	Block-based / JavaScript coding IDE with PlanetX extension
Classroom	Projector / Interactive Whiteboard	Teacher demonstrations and team code sharing
Classroom	Simulated Lunar Mission Environment	Large tray or floor area with: 4–6 obstacles, a marked "sample site," a marked "lunar base" return point, and optional varied terrain (ramps, ridges made from cardboard)
Classroom	LEV Design Brief & Mission Log Sheets	Structured planning and multi-run mission recording
Optional	Tape / Chalk for Mission Markers	Mark sample site, base, and navigation boundaries on the floor
Optional	AI Tool (e.g., Claude, ChatGPT)	Vocabulary support, debugging questions, LEV mission research

LESSON STRUCTURE — 5E MODEL

Total time: 3 × 45-minute class periods. Day 1: Design & Build | Day 2: Programming & Functionality | Day 3: Testing, Iteration & Presentation.

DAY 1: DESIGN & BUILD

ENGAGE — Introduce Context, Spark Interest & Identify Challenges (15 min)

Time	Activity	Teacher Actions	Student Actions
0–5 min	Entry Task & Context Introduction	Display prompt: "Imagine you are designing a robot to explore the Moon for 6 months. What 3 capabilities would it absolutely need — and why?" Also briefly introduce the concept of Lunar Exploration Vehicles and their scientific importance (soil sampling, terrain mapping, resource detection).	Write or sketch 3 capabilities with justifications. Post on the class board. These will be revisited in the Explain phase.
5–12 min	LEV Video Inspiration	Play a 3–4 min clip of a lunar or planetary exploration vehicle in action (NASA VIPER promo, Yutu-2 footage, or Apollo LRV driving). Pause and ask: "What systems can you see? What does each one do? What would happen if one failed?"	Watch and note 2 specific features observed. Discuss briefly with a partner: which feature seems hardest to engineer?
12–15	Lunar Environment	Facilitate discussion: What are the unique challenges of	Contribute to the table; record key challenges and

min	Challenge Discussion	operating a vehicle on the Moon? Build a class "Challenges → Engineering Solutions" table on the board (e.g., low gravity → wide wheelbase; no atmosphere → thermal insulation; signal delay → autonomous navigation).	solutions in notebooks for use during the design brief phase.

EXPLORE — LEV Construction (20 min)

Time	Activity	Teacher Actions	Student Actions
0–5 min	Design Brief	Distribute Design Brief sheets. Prompt teams: "Your LEV must have: (1) dual-motor drive for forward movement and turning, (2) a forward-mounted Sonar:bit for obstacle detection, (3) at least one mission attachment (robotic arm, sample scoop, antenna, camera mount). Sketch your design first — with all components labelled."	Sketch and label the full LEV design. Builder and Coder agree on chassis design and attachment concept before picking up any blocks.
5–20 min	Vehicle Construction	Circulate with guiding questions: "Are both drive wheels aligned so the LEV tracks straight?" "Is your Sonar:bit mounted at the front and aimed horizontally?" "Is your mission attachment secure and does it interfere with the drive system?" Encourage purposeful, design-led building.	Build the LEV. Builder leads construction; Coder plans the programming approach; Recorder documents every design decision and the reasoning behind it; Presenter prepares to explain the team's design rationale.

EXPLAIN — Key Components, Systems & Principles of Operation (10 min)

Time	Activity	Description
0–5 min	Design Discussion & Key Parts	Lead a class gallery walk or projected share: each team briefly describes one design decision they made and why. Then introduce the key components of a real LEV using a diagram: (1) Drive system — motors and wheels, (2) Sensing system — cameras, LIDAR, ultrasonic, (3) Power system — solar panels and battery, (4) Communication system — antenna and relay satellites, (5) Science payload — robotic arm, drill, spectrometer. Students annotate a printed diagram.

5–10 min	Principles of Operation	Explain how these components work together: the micro:bit acts as the onboard computer, the Sonar:bit acts as the sensing system, the motors act as the drive system. Introduce the concept of autonomous navigation: the vehicle reads sensor data, makes a decision, and acts — without waiting for a command from Earth. Connect to the signal delay challenge: signals to the Moon take 1.3 seconds each way; to Mars, up to 20 minutes. Ask: "Why does signal delay make autonomous navigation essential?"	

Classroom Management Tip — Day 1 Transitions

- Assign team roles before Day 1: Builder, Coder, Recorder, Presenter.
- Use a 2-minute warning timer before each phase transition.
- At the end of Day 1, photograph each LEV and upload to a shared class folder before packing away.
- Prepare the simulated lunar mission environment (obstacle course + sample site + base markers) before Day 3.

DAY 2: PROGRAMMING & FUNCTIONALITY

ENGAGE — Review, Connect & Coding Setup (10 min)

Time	Activity	Teacher Actions	Student Actions
0–5 min	Recap Quiz	Show 3 quick questions: (1) Name 2 systems of a real LEV and their functions. (2) Why does signal delay make autonomous navigation necessary? (3) What does parameter tuning mean? Teams confer and answer on mini whiteboards.	Discuss as a team; hold up whiteboard answers on teacher signal. Correct misconceptions before coding begins.
5–10 min	MakeCode Setup & Demo	Demonstrate: connecting dual drive motors and the Sonar:bit to the Nezha board. Show how to make the LEV move forward, turn left, and turn right using separate motor blocks. Confirm Sonar:bit reads a distance value and displays it on the LED.	Connect hardware; open MakeCode with PlanetX extension loaded. Coder confirms: (1) forward movement works, (2) turning works, (3) Sonar:bit displays a distance — before beginning the navigation program.

EXPLORE — Navigation, Mission Tasks & Parameter Tuning (25 min)

Time	Activity	Teacher Actions	Student Actions

0–15 min	Core Navigation + Mission Task Program	Display scaffold on board: forever loop → read Sonar:bit → IF distance < 15 cm THEN stop + turn → ELSE drive forward. Then add the mission task sequence: on button A pressed → navigate forward to sample site → stop 3 seconds (simulating sample collection) → LED displays "SAMPLE" → turn 180° → navigate back to base → stop + LED displays "BASE". Circulate and support.	Coder writes the navigation + mission task program; Builder tests motor connections during each trial; Recorder logs every code change and its effect on performance.
15–25 min	Parameter Tuning & Advanced Features	Prompt teams: "Test your Sonar:bit threshold — try 10 cm, 15 cm, 20 cm. Which works best on your course and why?" "Can you add an LED directional indicator showing which way the LEV is turning?" "Can you program a data logging simulation: every 5 seconds, display the current Sonar:bit reading on the LED as if the rover is reporting data to base?"	Tune motor speeds, Sonar:bit threshold, turn duration, and mission task pause length. Advanced teams add LED feedback, data logging simulation, or a second Sonar:bit reading at a different angle. Record all parameter changes in the Testing Log.

EXPLAIN — Code Sharing, Autonomous Navigation & Troubleshooting (10 min)

Time	Activity	Description
0–5 min	Code Showcase & Autonomous Navigation Discussion	Each team displays their MakeCode project for 90 seconds. The Coder explains: (1) how the obstacle avoidance logic works, (2) how the mission task sequence is triggered, (3) one parameter they tuned and why. Teacher connects to real autonomous navigation: "Real rovers use the same if-then logic, but with camera data instead of ultrasonic — and they make these decisions millions of times per second."
5–10 min	Troubleshooting Circle + Parameter Tuning Insights	Build a shared "Bug Board" and "Tuning Log" on the whiteboard. Document: common navigation bugs (spinning in circles, not turning far enough, stopping too early), their causes, and the solutions teams found. Also share which parameter changes had the biggest effect on performance — this teaches engineering thinking: small changes, observe, repeat.

Guided Inquiry Prompts for Teacher Use — Day 2

- "Your LEV turns but doesn't avoid the obstacle fully — is your turn duration long enough, or is the threshold too small?"
- "If you increase your Sonar:bit threshold from 10 cm to 20 cm, the LEV detects obstacles earlier. What is the trade-off of a very large threshold on a narrow course?"
- "Real rovers report sensor data back to Earth every few seconds. How could you simulate data logging with your LED display?"
- "Could your LEV navigate to two sample sites in sequence before returning to base? What code structure would you need for that?"

DAY 3: TESTING, ITERATION & PRESENTATION

ELABORATE — Lunar Mission Simulation: Test, Refine & Enhance (20 min)

Time	Activity	Description
0–15 min	Full Mission Simulation — 3 Timed Runs	Teams deploy their LEV on the simulated lunar mission environment. Each run is timed. After each run, complete the Mission Log: Did the LEV avoid all obstacles? Did it reach the sample site and pause? Did it return to base successfully? Was the LED mission status displayed correctly? Make one targeted improvement between each run and record the change.
15–20 min	Advanced Enhancements (Stretch)	Teams that complete 3 successful full missions choose one enhancement: (A) Add a second waypoint — LEV navigates to two sample sites in sequence before returning to base. (B) Program simulated data logging: LEV displays Sonar:bit readings on the LED every 5 seconds during navigation. (C) Build and integrate a physical sample scoop attachment from blocks — demonstrate it "collecting" a marked object at the sample site. (D) Use micro:bit radio: one micro:bit acts as Mission Control and uplinks a "Go" command; the other (on the LEV) triggers the mission task sequence on receipt.

Mission Simulation Testing Protocol

- Run 1: Navigation check — does the LEV move forward and avoid all obstacles? Record: Pass / Partial / Fail. Note which obstacle caused problems.
- Run 2: Mission task check — does the LEV reach the sample site, pause, and return to base? Record: Yes / Partial / No. Note timing accuracy.
- Run 3: Full mission — obstacle avoidance + sample collection + base return + LED status. Time the run and evaluate: Meets / Approaching / Not Yet.

- After 3 runs: implement the single most impactful improvement before the final presentation.

EVALUATE — Presentations, Peer Feedback & Reflection (25 min)

Phase	Time	Description
Vehicle Demonstrations & Presentations	4–5 min / team	Presenter explains: (1) design choices — why each LEV system was designed as it was, including the mission attachment, (2) programming logic — how the obstacle avoidance works, how the mission task is triggered, and which parameter tuning had the biggest effect, (3) science connection — how the LEV connects to real lunar exploration science. Live full mission simulation runs during the presentation.
Peer Feedback	2 min / team	Audience completes a "2 Stars & 1 Wish" card per team: 2 specific strengths observed + 1 targeted, constructive suggestion. Cards are given to presenting teams at the end of the session.
Wrap-Up Reflection & Series Review	5 min	Whole-class discussion: "What has changed in your engineering thinking between Lesson 01 and Lesson 05?" "Which lesson's challenge was hardest — and why?" "If you were designing a real LEV for NASA's Artemis program, what one feature from your model would you keep — and what would you completely redesign?" Celebrate the full series journey.

DIFFERENTIATION STRATEGIES

Learner Group	Strategy	Concrete Example
Beginning / SEN	Scaffolded tasks with visual supports	Pre-built starter LEV chassis to modify; illustrated step-by-step coding guide; visual flowchart of the full navigation + mission task program structure
Beginning / SEN	Reduced scope	Focus on forward drive + obstacle stop only (no mission task waypoint); use sentence starters for reflection; annotate printed code screenshots instead of writing from scratch
ELL Students	Language support	Bilingual vocabulary card for all 8 key terms; permit labelled diagrams instead of written explanations; pair with a bilingual peer where possible

ELL Students	Comprehensible input	Physical demonstrations alongside all verbal instructions; printed hardware setup cards with annotated images for dual-motor and Sonar:bit connections
Average Learners	Core task completion	Complete the full navigation + single mission task program; navigate the course successfully in 3 runs; explain 2 LEV systems and 2 physics/engineering principles in the presentation
Advanced Learners	Open-ended extensions	Add LED directional indicators; program simulated data logging; add a second waypoint; tune parameters systematically and report results; reference a real LEV mission in the presentation
Gifted / High Ability	Challenge by choice	Design micro:bit radio Mission Control uplink; build a physical sample scoop attachment; programme a two-waypoint mission; write a brief engineering report comparing their LEV to NASA’s VIPER or Yutu-2

ASSESSMENT — FORMATIVE & SUMMATIVE

Formative Assessment (Ongoing — During the Lesson)

Method	When	What to Look For
Entry Task: 3 Capabilities	Day 1, 0–5 min	Surface prior knowledge and creativity around LEV design; note which challenges students already understand
Challenges → Solutions Table	Day 1, 12–15 min	Check depth of understanding of real lunar environment engineering constraints before building
Design Brief Review	Day 1, Build phase	Assess whether sketches include dual motors, Sonar:bit placement, and a described mission attachment with justification
Mini Whiteboard Recap Quiz	Day 2, 0–5 min	Verify retention of LEV systems, signal delay concept, and parameter tuning definition from Day 1
Hardware Confirmation Check	Day 2, Setup phase	Confirm dual motors run correctly and Sonar:bit reads a distance before navigation programming begins
Parameter Tuning Log Review	Day 2, Explore phase	Check that Recorder is documenting each parameter change with a reason — this develops real engineering discipline

Code Sharing Spot-Check	Day 2, Explain phase	Verify navigation logic, mission task trigger, and that at least one parameter has been tuned with a stated reason
3-Run Mission Log	Day 3, Elaborate phase	Assess iterative thinking: did teams identify specific failures and make targeted, reasoned improvements between runs?
Exit Ticket (3-2-1)	End of Day 3	3 LEV systems/science connections learned; 2 parameter changes made and their effects; 1 connection to a real lunar or planetary mission

Summative Assessment (End of Lesson)

Criterion	Beginning (1)	Developing (2)	Achieving (3)	Exceeding (4)
Design & Build	LEV is incomplete or Sonar:bit/motors are not properly mounted	LEV moves but has alignment or sensor mounting issues; mission attachment is missing or non-functional	LEV is stable with aligned dual-motor drive, correctly mounted Sonar:bit, and a functional mission attachment	LEV is robust and detailed; mission attachment is well-engineered; design shows clear consideration of real LEV principles
Programming	Code does not run or motors do not respond to sensor input	Code runs but navigation is inconsistent or mission task sequence is incomplete	Code reliably navigates the obstacle course and executes the full mission task sequence (sample site → base return)	Code includes parameter-tuned thresholds, LED data logging, directional indicators, second waypoint, or radio Mission Control link
Science Knowledge	Cannot name LEV systems or explain their purpose	Names 1–2 systems or challenges with prompting	Explains 3 LEV systems, 2 engineering challenges, and 2 physics/engineering principles independently	Connects design, code, and parameter choices to real LEV mission data; references VIPER, Yutu-2, or Perseverance accurately
Collaboration	Does not contribute	Contributes minimally;	Contributes consistently across	Leads or mentors peers;

	meaningfully across the 3 days	needs frequent prompting to stay on task	all 3 days; all team members participate in design, coding, testing, and presentation	adapts role as needed; documents decisions systematically; resolves disagreements constructively
Presentation	Presentation is unclear; live mission demo does not complete	Presents with some clarity; limited explanation of navigation logic, mission tasks, or science connections	Clearly presents LEV design, navigation code, mission task program, and science connections; live demo completes successfully	Presents with confidence and technical vocabulary; explains parameter tuning choices; responds well to questions; makes strong real-world connections

TECHNOLOGY & AI INTEGRATION

Tool / Platform	How to Use in This Lesson
MakeCode (makecode.microbit.org)	Primary coding environment; block view for beginners, JavaScript view for advanced; use the simulator to prototype navigation logic before flashing to hardware
micro:bit v2 + Nezha Board + Dual Motors + Sonar:bit	Full physical computing stack; independent left/right motor control enables precise turning; Sonar:bit provides real sensor input for conditional navigation and data logging simulation
micro:bit Radio (Advanced)	Pairs of micro:bits communicate wirelessly to simulate Mission Control uplink — one sends a "Go" command, the other triggers the mission task sequence on receipt
AI Chatbot (Claude / ChatGPT)	Students can ask: "How does NASA's VIPER rover navigate in the permanently shadowed regions of the Moon?" or "Why isn't my turn block working after obstacle detection?" Teach responsible AI use: verify facts, test code yourself
NASA VIPER & Yutu-2 Resources	NASA's VIPER mission page and CNSA Yutu-2 updates provide real-world data for students to compare against their own LEV design decisions
QR Code Resource Stations	Link to MakeCode starter project, dual-motor wiring diagram, vocabulary glossary, and mission environment setup guide for independent and differentiated pacing
Padlet / Google Slides Portfolio	Digital gallery for LEV build photos, testing log results, and parameter tuning charts; allows structured peer comments across teams

AI Responsible Use Guidance for Students

- Use AI to help understand vocabulary, debug navigation code, or research real LEV missions — always verify from an official NASA or ESA source.
- Test any AI-suggested code yourself and explain what each block does before presenting.
- Do not copy AI-written explanations — use them as a starting point and restate the ideas in your own words.
- When comparing your LEV to VIPER or Yutu-2, note the differences honestly — AI can help you identify them, but your analysis should be your own.

REAL-WORLD CONNECTIONS

Connection	Discussion Prompt
NASA VIPER Rover (upcoming)	"NASA's VIPER rover will map water ice deposits in the permanently shadowed craters near the Moon's south pole. Why is water ice on the Moon important — and how does obstacle avoidance become critical in areas with no sunlight and no GPS?"
China's Yutu-2 (2019–present)	"Yutu-2 has been exploring the Moon's far side for over 5 years, longer than any other lunar rover. It receives mission commands from Earth via a relay satellite. How does your micro:bit radio simulation connect to this relay communication model?"
Mars Perseverance Rover	"Perseverance navigates autonomously using AI and stereo cameras — and it drills into rocks to collect samples. How is your mission task sequence (navigate → stop at sample site → return) similar to Perseverance's daily operations?"
Apollo Lunar Roving Vehicle (1971–1972)	"The Apollo LRV was crewed and driven manually at up to 17 km/h. Modern lunar rovers are fully autonomous. What are the trade-offs of crewed vs autonomous operation — speed, safety, cost, scientific value?"
Future Lunar Resource Extraction	"Scientists believe the Moon's south pole may contain enough water ice to support a permanent lunar base. What role would LEVs play in extracting, processing, and transporting those resources?"
Careers in Robotics & Space Exploration	"What careers are involved in designing, building, and operating a real LEV? Robotics engineer, AI systems developer, materials scientist, mission planner, data analyst — which connects most to your work in this lesson?"

EXTENSION ACTIVITIES

Activity	Description	Suggested For

Lunar Rover Research Report	Research 3 lunar or planetary rovers (e.g., Apollo LRV, Yutu-2, VIPER, Perseverance). Compare their drive systems, sensing systems, mission objectives, and operational lifespans in a 1-page illustrated summary.	Average & Advanced
Multi-Terrain Simulation	Set up the mission environment with 3 terrain zones: flat regolith (floor), cratered area (bumpy cardboard), and a slope (ramp). Test the LEV on each terrain. How does the obstacle avoidance threshold need to change? Record and explain findings.	Advanced / Gifted
Two-Waypoint Mission Sequence	Program the LEV to navigate to two separate sample sites in sequence before returning to base. Add an LED status display showing which waypoint the LEV is currently targeting. Time the full mission and compare runs.	Advanced / Gifted
Future Lunar Exploration Presentation	Create a 3-minute multimedia presentation on NASA's VIPER mission or China's Chang'e-7 rover plan: mission goals, landing site selection, sensing systems, and how the rover will map lunar water ice deposits.	All levels
Simulated Data Logging Report	Program the LEV to display Sonar:bit readings every 5 seconds on the LED during navigation. Manually record each reading during a timed run. Graph the readings vs time. Identify where obstacles were detected and correlate to the course map.	Advanced / Gifted
Mission Control Radio Simulation	Use two micro:bits with radio communication. Mission Control sends coded commands (A = Go, B = Abort, shake = emergency stop). The LEV micro:bit responds to each command in real time. Simulate a full mission with Mission Control commentary.	Gifted

HOMEWORK / FOLLOW-UP TASKS

Task	Instructions	Due
LEV & Series Reflection Journal	Write 200–250 words reflecting on both this lesson and the full Lessons 01–05 series: What engineering skill improved the most across the 5 lessons? What was the biggest challenge in Lesson 05 specifically? If you were continuing to Lesson 06, what would you want to build next?	Next class
Real LEV Mission Connection	Find a news article or video about NASA's VIPER rover or China's Chang'e programme published in the last 2 years. Write 3 sentences: (1) what the mission aims to achieve, (2) one similarity to your LEV, (3) one major engineering difference and why it exists.	Next class

Extension (Optional)	Design a "Lunar Exploration Vehicle Upgrade Plan": sketch your LEV with 3 specific improvements you would make if you had one more class period. For each improvement, name it, describe it in one sentence, and explain why it would make your LEV more effective as a real exploration vehicle.	Next class

TEACHER NOTES & TIPS

Before the Lesson

- Review Lessons 01–04 student portfolios to identify any teams with persistent skill gaps — assign targeted support for Day 2 coding.
- Test all dual-motor connections and Sonar:bit sensors at least one day in advance; confirm the PlanetX extension is installed on all classroom computers.
- Build the full simulated lunar mission environment before Day 3: obstacle course (4–6 objects), a marked sample site (coloured tape or card), a marked lunar base return point, and optional terrain variation (cardboard ramps or ridges).
- Print LEV Design Brief sheets, vocabulary cards, Mission Log sheets, and Parameter Tuning logs for each team.
- Bookmark VIPER, Yutu-2, and Apollo LRV video clips on a dedicated browser tab for Day 1.
- If using micro:bit radio for the extension, pair and test radio channels for each team in advance.

During the Lesson

- Lesson 05 is the capstone of the series — celebrate that explicitly with students at the start of Day 1.
- The key distinction from Lesson 03: Lesson 05 adds a mission task sequence (navigate → sample → return) on top of obstacle avoidance. Make this explicit in the Day 2 coding scaffold.
- Encourage systematic parameter tuning: change one variable at a time, observe the effect, and record it. This is real engineering methodology.
- If a team's LEV spins in circles, the most common causes are (1) unequal motor speeds — reduce the faster motor; (2) turn duration too long — reduce pause time; address both as calibration teaching moments.
- For SEN students, the Recorder and Mission Log roles allow full and meaningful participation.
- Use the wrap-up reflection to explicitly connect the full 5-lesson journey: Lesson 01 (launch pad) → Lesson 02 (rocket) → Lesson 03 (rover nav) → Lesson 04 (lander) → Lesson 05 (full exploration mission).

After the Lesson

- Photograph each team's final LEV and compile a full series portfolio (Lessons 01–05) for each team.
- Consider hosting a "Space Science Kit Exhibition" where all 5 lesson builds are displayed together with student explanations.
- Compile the Bug Board and Parameter Tuning Log into a shared class reference document.
- Use reflection journal responses to inform planning for the next unit or an inter-class LEV mission challenge.
- Celebrate student achievement explicitly — completing 5 progressively complex engineering lessons is a significant accomplishment.

CURRICULUM STANDARDS ALIGNMENT

Standard Framework	Alignment
NGSS (Next Generation Science Standards)	MS-PS2-1 & 2: Forces and Motion; MS-PS3: Energy; MS-ETS1-1 to 1-4: Engineering Design; HS-ETS1-2: Design solutions for complex, real-world problems
CSTA (Computer Science)	Level 2 (Grades 6–8): Multi-condition algorithms, sensor input, event-driven programming, parameter tuning, iterative debugging, and autonomous system design

ISTE Standards (Students)	Empowered Learner, Innovative Designer, Computational Thinker, Creative Communicator, Global Collaborator
Common Core (Supporting)	Data recording and analysis across mission runs; ratio reasoning in parameter tuning; structured oral presentation with technical vocabulary
21st Century Skills (4Cs)	Critical Thinking (navigation and mission debugging), Creativity (LEV design and mission attachments), Collaboration (team roles across 3 days + series), Communication (capstone mission presentations)
Series Culmination	Lesson 05 is the capstone of the Space Science Kit Lessons 01–05 series, integrating all prior learning into a comprehensive autonomous lunar exploration mission

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