

AURORA HYBRID LIFT RESEARCH MISSION 001

A source-linked, evidence-led instructor guide and twelve-week educational thesis



Research status: educational program proposal. Existing physical principles are documented, but the proposed integrated Aurora vehicle has not been validated. No occupancy, flight, submergence, or NASA partnership is claimed.

Student concept acknowledgement: Leah Paige (age 14) contributed ideas and research to the Aurora concept. The AHF team is responsible for checking the scientific interpretation before public use.

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Executive thesis and research boundary

Research question. Can a small unmanned educational platform demonstrate, in separate bounded tests, (1) induced-current magnetic support over an engineered guideway, (2) displacement-based buoyancy in water, and (3) near-surface air-cushion support; and can traceable test data identify what future mode integration would require?

Working hypothesis. Each of these distinct force mechanisms can be demonstrated in appropriate conditions. An integrated multi-mode transition remains an unvalidated engineering question. A body of ordinary water is not a practical passive magnetic guideway, and a water tank does not provide unlimited energy.

Scope. Classroom force balance, experimental design, measurements, research literacy and simulated mode decisions. No human-riding apparatus, real high-altitude flight, controlled deep-water submergence, hydrogen process or high-energy magnetic levitation rig is part of the youth curriculum.

Key research classifications

TERM	WHAT CAN BE SAID
Established	A physical principle independently documented in credible sources.
Calculated	A numerical result under explicit assumptions; not necessarily a measured outcome.
Proposed	A design or experiment awaiting build and observation.
Observed	Actual measured data tied to configuration, date, units and uncertainty.
Speculative	A concept with no validated mechanism in the stated application.

Teaching philosophy

A meaningful class exercise starts with a prediction that can fail. Students record a control, measured quantity, units, uncertainty, alternative explanation and a decision. Animated renderings provide context, but they are not testing evidence.

Engineering mechanisms: do not conflate them

LAND / WHEELS

Contact forces and traction support the vehicle on ordinary ground. Wheel/tread geometry and control require testing.

MAGNETIC GUIDEWAY

A Halbach magnet array may interact with induced track currents when there is an engineered guideway and relative motion. Passive systems need wheel fallback at low speed; no ordinary-ground free hover.

WATER / BUOYANCY

Displaced-fluid weight creates upward force. Stability, trim and hull pressure ratings remain separate questions.

AIR CUSHION / SURFACE

A suitable air-cushion system maintains a small gap near a surface; leakage, fan power and pressure control govern its feasibility.

WING / AIRBORNE FLIGHT

Airflow around lifting surfaces can produce lift. Sustained free flight demands a complete aerodynamic and control system, not just a hovercraft.

Four classroom equations

Weight: $F = m \times 9.81 \text{ m/s}^2$

A 1.5 kg scale model weighs about 14.7 N near Earth.

Buoyancy: $F_b = \rho_{\text{water}} \times g \times V_{\text{displaced}}$

Fresh water density about 1000 kg/m³; displacement volume must be in cubic meters.

Ideal cushion pressure: $P = m \times g / A$

This is a static balance, not a fan, efficiency or altitude model.

Airfoil lift: $L = 0.5 \times \rho_{\text{air}} \times V^2 \times A \times C_L$

The coefficient, velocity and area must be defined; NASA Glenn describes the equation.

The 12-week learning sequence

Intended for teachers and supervised exploratory learners. Each week can be one or more sessions. No procurement, test facility or safety approvals are implied by the schedule.

Evidence record for every week: hypothesis, sources, variables, measurement method, uncertainty, result, alternate explanation and next question.

WEEK 1 / FOUNDATIONS

Forces and requirements

Objective: Distinguish weight, lift, buoyancy, support and the vehicle's actual requirements.

Scientific context: Every mode of transportation must balance forces. Weight is m times g . Wheel reaction, pressure-supported air cushion, displaced-water buoyancy, aerodynamic lift and magnetic forces are different mechanisms. Aurora imagery suggests all of them, but illustrations are not test results. The first prototype should solve one bounded problem at a time.

Classroom investigation: Draw a labeled force diagram for a stationary 1.5 kg model. Its weight on Earth is about 14.7 N. State which upward support actually acts in each mode.

Evidence: Requirement AHF-M01 and a four-mode force diagram.

Review check: Which expression gives weight near Earth?

WEEK 2 / FOUNDATIONS

Hypothesis, uncertainty and controls

Objective: Write testable claims with controls, repeat trials and units.

Scientific context: A research claim becomes meaningful when a different observer could repeat the test. Predefine a prediction, an instrument, controls and an acceptance threshold. Separate a measured observation from a calculated estimate. Record configuration, sources of error and whether the outcome contradicts your initial expectation.

Classroom investigation: Write one prediction that could fail: a balloon hovercraft has lower sliding resistance on a smooth board with its balloon inflated, compared with deflated. Plan three repetitions for each condition.

Evidence: A two-condition test sheet with predictions, three observations and uncertainty notes.

Review check: Which entry is an observation?

WEEK 3 / MAGNETIC GUIDEWAY

Halbach arrays and induced currents

Objective: Explain why magnetic guideway levitation requires compatible track materials and architecture.

Scientific context: Inductrack research uses permanent magnets arranged in Halbach arrays, together with a circuit-filled guideway. Relative motion induces currents and repulsive forces. Magnetic lift in such a design depends on the engineered track; it is not an open-air free-hover method. Classroom demonstrations should use low-energy equipment chosen by a qualified teacher.

Classroom investigation: Draw a simplified moving magnet, track coil and induced current. Explain where the return energy goes when motion stops.

Evidence: Guideway sketch plus a list of prerequisites and failure states.

Review check: Where does an Inductrack-style system develop useful levitation forces?

WEEK 4 / MAGNETIC GUIDEWAY

Transition speed and safe fallback

Objective: Plan the wheel/guideway handoff without pretending it has been validated.

Scientific context: Passive induced-current levitation can require minimum motion; auxiliary wheels support the vehicle below the transition region. A useful feasibility review would require actual coil geometry, magnetic forces, material limits, lateral guidance, braking and power losses. Do not infer a full-sized vehicle's speed or payload from classroom magnets.

Classroom investigation: Draw a sequence: wheel supported; moving above guideway; permitted levitation; slow-down return to wheels. Mark three stop conditions.

Evidence: Transition-state diagram and stop checklist.

Review check: What is a prudent fallback when passive maglev speed drops?

WEEK 5 / BUOYANCY

Water displacement and density

Objective: Calculate buoyant force and compare it to model weight.

Scientific context: An object displaces water. By Archimedes' principle, the upward buoyant force equals the displaced water's weight. The approximate relation is $F_b = \rho_{\text{water}} \times g \times \text{displaced volume}$. Changing gas pressure within a rigid sealed outer hull does not change the displaced external volume; a practical ballast system requires a real mass or displacement change.

Classroom investigation: Use the buoyancy calculator: vary model mass and submerged displaced volume until buoyancy equals the weight. State whether your result ignores stability.

Evidence: Three mass/volume trials and a written margin-of-buoyancy conclusion.

Review check: What causes the upward force on a floating boat?

WEEK 6 / BUOYANCY

Trim, stability and recovery

Objective: Recognize that floating does not ensure a stable or recoverable design.

Scientific context: Floating support depends on total displacement, but practical vessels also need stable trim, center of gravity, center of buoyancy, waterproof compartments and recovery strategies. An underwater pressure-rated hull is a separate major challenge; no safe occupancy, pressure depth or diving operation can be inferred from a school float test.

Classroom investigation: Place paper weights in different locations on a small floating model and record lean angle and recovery. Do not run deep-water or pressure experiments.

Evidence: Three trim observations and a low-risk recovery procedure.

Review check: Can a sealed, rigid chamber change the craft's external displacement just by rearranging its internal gas?

WEEK 7 / AIR CUSHION

A cushion of air vs free flight

Objective: Separate ground-effect air cushion support from airborne flight at height.

Scientific context: NASA JPL shows simple hovercrafts that float on cushions of air above surfaces. A pressure-supported air cushion can reduce friction and may function over suitable water surfaces. It depends on airflow, pressure and a small gap; it does not automatically provide high-altitude flight. Fan thrust is an engineering and safety issue distinct from aerodynamic wing lift.

Classroom investigation: Compare a balloon/CD hovercraft, a floating boat, and a flying paper airplane. Label which force supports each.

Evidence: Mode comparison diagram and description of the surface needed.

Review check: Which statement is scientifically sound?

WEEK 8 / AIR CUSHION

Pressure, area and energy

Objective: Compute minimum ideal cushion pressure and list unknown losses.

Scientific context: In a simplified static balance, minimum average cushion pressure $P = \text{mass} \times g / \text{support area}$. Actual engineering must add leakage, surface variation, skirt behavior, fan curves, control stability, energy consumption and safe shutdown. An ideal pressure calculation does not size a fan or establish safe human carriage.

Classroom investigation: Calculate P for a 1.5 kg toy and an effective area of 0.25 m^2 . Discuss how a leak changes required airflow.

Evidence: Calculated pressure, assumptions list and one practical leakage question.

Review check: For the same mass, doubling the cushion area does what to ideal required pressure?

WEEK 9 / SYSTEM INTEGRATION

Power, momentum and mode transitions

Objective: Identify distinct energy and control needs for tracks, buoyancy, magnetic guideways and air support.

Scientific context: No propulsion concept is validated merely because a vehicle carries water or hydrogen. Energy must come from a defined source, and motion must exchange momentum or forces with the surroundings. A multimode craft needs explicit isolation, load cases, failure states, seals, thermal management and a truthful power ledger. Water can be ballast, coolant or feedstock for a separately powered process, not a free energy source.

Classroom investigation: Draw an energy-in/energy-out map for wheel mode, guideway mode and water mode. Identify one unverified interface.

Evidence: A three-mode energy ledger and interface risk table.

Review check: Which assertion is correct?

WEEK 10 / SYSTEM INTEGRATION

Sensors and fault response

Objective: Define the information needed to measure, navigate and safely stop an unmanned prototype.

Scientific context: Sensors may include load cells, an inertial measurement unit, current meters, temperature readings, water level and GPS where appropriate. Data logs should record units, calibration, timestamps and software version. Define a safe state when a sensor fails. Never infer that a map or Garmin route by itself is a certified autopilot, obstacle avoidance or aviation approval.

Classroom investigation: Choose three sensors for a scale platform, define measurement units and specify what happens when one fails.

Evidence: Three-row sensor specification and fault-state checklist.

Review check: What makes a research sensor reading useful?

WEEK 11 / PEER REVIEW

Challenge assumptions and review evidence

Objective: Classify evidence, disclose limitations and verify claims.

Scientific context: A useful engineering team asks what would make a design fail, not only what makes it attractive. Have a second group audit the experiment, reproduce calculations and find missing uncertainties. Use claim labels: established; calculated with assumptions; proposed; observed with data; speculative. Do not present outreach or NASA public references as formal NASA collaboration.

Classroom investigation: Choose two claims about hover and rewrite them with evidence categories and a proposed test.

Evidence: Peer-review checklist and revised claims with linked sources.

Review check: Which phrase is a responsible public claim for an untested integrated Aurora hovercraft?

WEEK 12 / PUBLIC RELEASE

Publish a defensible research story

Objective: Create a reader-friendly report that keeps conclusions and limitations together.

Scientific context: A strong STEM exhibit presents the question, known physics, measured data, errors, sources and next step. Include student attribution, configuration version, controlled diagrams and an uncertainty or limitations panel. No prototype should be presented as tested unless specific dated measurements exist. Share the school and community initiative without implying third-party endorsement or credit.

Classroom investigation: Write a 250-word research abstract and present a three-minute demonstration of one validated classroom principle.

Evidence: Final abstract, source list, recorded result, limitations and next-gate decision.

Review check: Which item belongs in a responsible final research release?

Guided simulators and their limits

All figures on the website are mathematical teaching examples. They are not validation of Aurora, the full-scale hull, thrusters, pressure controls or engineering certifications.

Buoyancy calculator

Given mass m in kg and maximum displaced volume V in liters, use $F_b \approx 9.81 \times V$ newtons for fresh water near Earth, and weight $m \times 9.81$. If $F_b < \text{weight}$, this assumed displacement cannot support the mass. If $F_b \geq \text{weight}$, the force balance alone does not establish stable trim.

Air-cushion pressure

Given model mass and effective support area A in m^2 , $P_{\text{ideal}} = m \times 9.81 / A$ pascals. Fan leakage, wave conditions, skirt design, heat and power use are absent.

Magnetic guideway prerequisites

A track with suitable shorted circuits and sufficient relative speed is a necessary condition in Inductrack-style passive systems. This curriculum does not compute actual transition speed or magnetic force, because that needs detailed array and guideway geometry.

Wing lift model

$L = 0.5 \times \rho_{\text{air}} \times V^2 \times A \times C_L$; the browser uses $\rho_{\text{air}} = 1.225 \text{ kg/m}^3$ as a teaching assumption. The lift coefficient is a user-chosen hypothetical value; not a value measured for Aurora.

Never label a simulator result as a completed test or approved hardware rating.

Teaching game and assessment rubric

Four scenario choices form a causal concept game: a land road requires wheel reaction; an engineered maglev track requires compatible guideway and motion; a sealed float uses displaced-water support; and an air cushion is near-surface pressure support, not automatic high-altitude flight.

Scorecards

ACTIVITY	SUCCESS CRITERION	RECORD
12 lessons	Explain one force mechanism and answer its check.	12 local completion markers
4-stage mission	Choose the suitable support system in each environment.	Best score / 4
Research assessment	At least 9 of 12 source-linked checks correct.	Local Research Ready badge
Research notebook	Describe a hypothesis, controls, data and limitations.	User-exported JSON file

Voice teaching characters

Merlin / Captain J3: a fictional Quest Club-inspired learning companion that explains scientific mechanisms using a curated local answer library. **Discovery Navigator:** a bright synthetic teaching persona. **Science Coach:** a measured narrator emphasizing questions and uncertainty. Browser TTS voices are optional and device-dependent; they do not clone or impersonate any real person.

Data and privacy

The web lesson currently stores progress and lab entries only in the current browser localStorage. No student account, external learning management system, personal profile, server analytics, or verified certificate issuance is included. Export notebook files before clearing browsing data. Site administrators should evaluate education privacy practices before expanding to identified pupils.

Safety, hazard and stop conditions

Classroom experiments use carefully supervised low-energy materials. The program never authorizes building a passenger-capable hovercraft, manned submersible or experimental flying device.

Minimum hazard register

MODE	HAZARD	CLASSROOM CONTROL
Magnetic	Pinching, projectiles, medical implants, high currents.	Use safe demonstration imagery or qualified-lab setups; avoid unguarded magnets.
Water	Slips, electricity near liquids, capsizing.	Low-voltage or no-electricity float models, shallow trays and adult supervision.
Air cushion	Spinning fans, sharp fragments, noise, stored energy.	Balloon/CD demonstration only for youth; never exposed powered rotors.
Mechanical	Pinch points, abrupt motion, falling devices.	Light toy models and small controlled surfaces, no riders.
Data	Wrong units, overclaims, private records.	Record assumptions and units; export securely; do not collect learner identifiers.

Stop conditions before any physical prototype

- Unqualified test supervisor, uncontrolled motion or unsafe power source.
- Missing risk review for the specific material, mechanical boundary or test area.
- No reliable emergency stop, recovery method or protection for observers.
- Unknown legal restrictions, landowner consent, aircraft rules or waterway access.
- Any discrepancy between public claims and actually observed measurements.

Printable field-research worksheet

Researcher name or class group: _____

Test identifier / configuration: _____

Date, supervised setting, and mode: _____

Prediction and how it could be disproved:

Controlled variables and safety boundary:

Trial data with units:

TRIAL	INDEPENDENT VARIABLE	MEASUREMENT / UNITS	NOTES
1			
2			
3			
4			
5			

Result, uncertainty, alternative explanation and next action:

Selected public references and source ethics

[NASA JPL, Make a Hovercraft](#)

[NASA Glenn Research Center, Lift Equation](#)

[NOAA Education, Build a Boat](#)

[NASA NTRS, The NASA Inductrack Model Rocket Launcher](#)

[IEEE, The Inductrack: A Simpler Approach to Magnetic Levitation](#)

Research governance and credit

This independent AHF educational work draws on publicly available teaching materials and research literature; citations do not imply cooperation, licensing, sponsorship or endorsement by NASA, NOAA, IEEE or any university.

Contributors. Appalachian Heroes Foundation / Exploration STEM Academy. Aurora concept youth research acknowledgement: Leah Paige, age 14. Quest Club and Captain J3 are original AHF storytelling concepts; Merlin is a fictional educational interpretation, not an officially affiliated AI platform.

Direct giving. AHF community pages link to recipients' independently operated donation or contact channels; institutional acknowledgements are not claims of financial support or agreements.

Useful website links: [AHF Mission 001 learning lab](#); [Community sponsor directory](#).

FINAL RELEASE CHECK

Before displaying simulated values as measured results: provide a configuration ID, dated raw data, calibration or limits, independent review, and context. Until then, every full Aurora flight, submergence and multi-mode integration capability stays proposed.