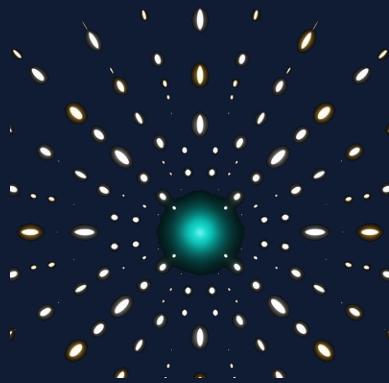




LAUE LABS



Curriculum A

30-Week Elementary-to-Middle-School Program

Thirty hands-on builds, from launching projectiles to a working animatronic hand.

OCTOBER 2026

Curriculum A

Document: LAUE-CURR-A · Version 1.1 · October 2026 **Publisher:** Laue Labs (lauelabs.com)

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This document — sequence, pacing, objectives, and assessment — may be shared freely with educators evaluating the program. The build instructions, cut files, code, and lessons of the Laue Labs project packs are proprietary to their licensed packs and are not reproduced here.

Hardware cost estimates are approximate and based on typical U.S. retail component pricing at the time of publication; actual costs vary by supplier.

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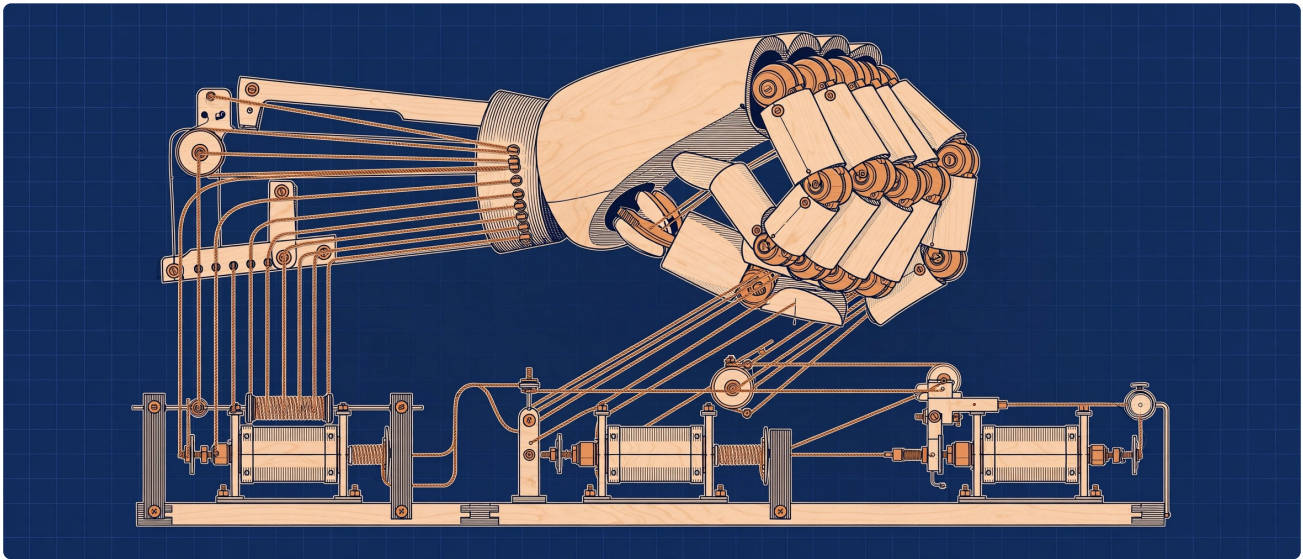
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About Laue Labs

Laue Labs (lauelabs.com) designs hands-on engineering project packs — digital build guides, laser-cut files, code, lessons, and bills of materials — for students ages 8–14, families, makers, and classrooms. Each pack is a complete guided apprenticeship in real engineering: build it, test it, measure it, explain it. The company is named for Max von Laue, whose X-ray diffraction work revealed the structure of crystals — the same spirit of learning by probing the physical world drives every kit.

How to use this document

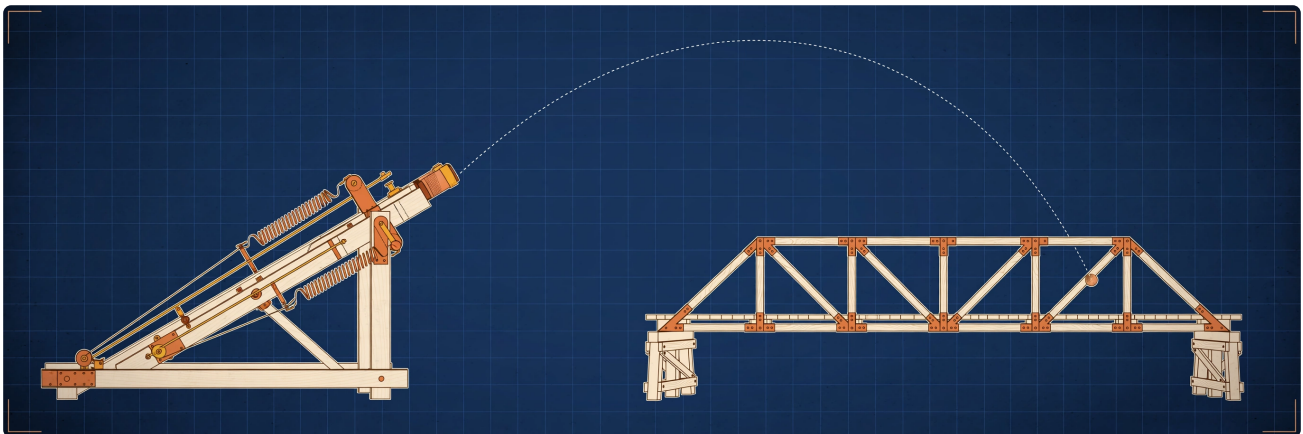
Front matter orients you: what the program is, how it's organized, and what's in each section. **The body** is the curriculum itself — units, weeks, objectives, and assessment. **The back matter** holds the reference appendices: glossary, master hardware index, standards alignment, and document history. A companion **Teacher's Guide** provides the week-by-week execution plans — timed agendas, launch scripts, checkpoints, and failure rescues — for running every session.



CURRICULUM A — 30 Weeks, Elementary to Middle School

One school year. Thirty builds. From launching projectiles to a working robot hand.

Unit 1 · Push, Pull & Play — Motion and Structures (Weeks 1–5)



Standards: MS-PS2 (motion and forces), MS-ETS1 (engineering design)

Week 1 — Ballista Physics Lab

- **Big question:** What launch angle sends it farthest?

- **Key idea:** Things fly in curves; the angle you launch at changes where they land.
- **Build:** Birch ballista; launch soft projectiles at different angles and measure.
- **Show what you learned:** A hand-drawn chart of angle vs. distance with the winner circled. *Hardware ~\$19–61.*

Week 2 — Bridge Load Lab

- **Big question:** Where does a bridge hide its strength?
- **Key idea:** Triangles are strong; force travels along paths you can see when things break.
- **Build:** Laser-cut birch truss; load it until it fails — on purpose.
- **Show what you learned:** Sketch the broken bridge with the broken pieces marked; point to where the force went. *Hardware ~\$14–58.*

Week 3 — Gear Ratio Lab

- **Big question:** Would you rather lift heavy or spin fast?
- **Key idea:** Gears trade speed for strength. Big driving small = fast; small driving big = strong.
- **Build:** Birch gear train; feel the difference with your own hands.
- **Show what you learned:** Demo both setups and explain which you'd pick to lift a backpack. *Hardware ~\$16–71.*

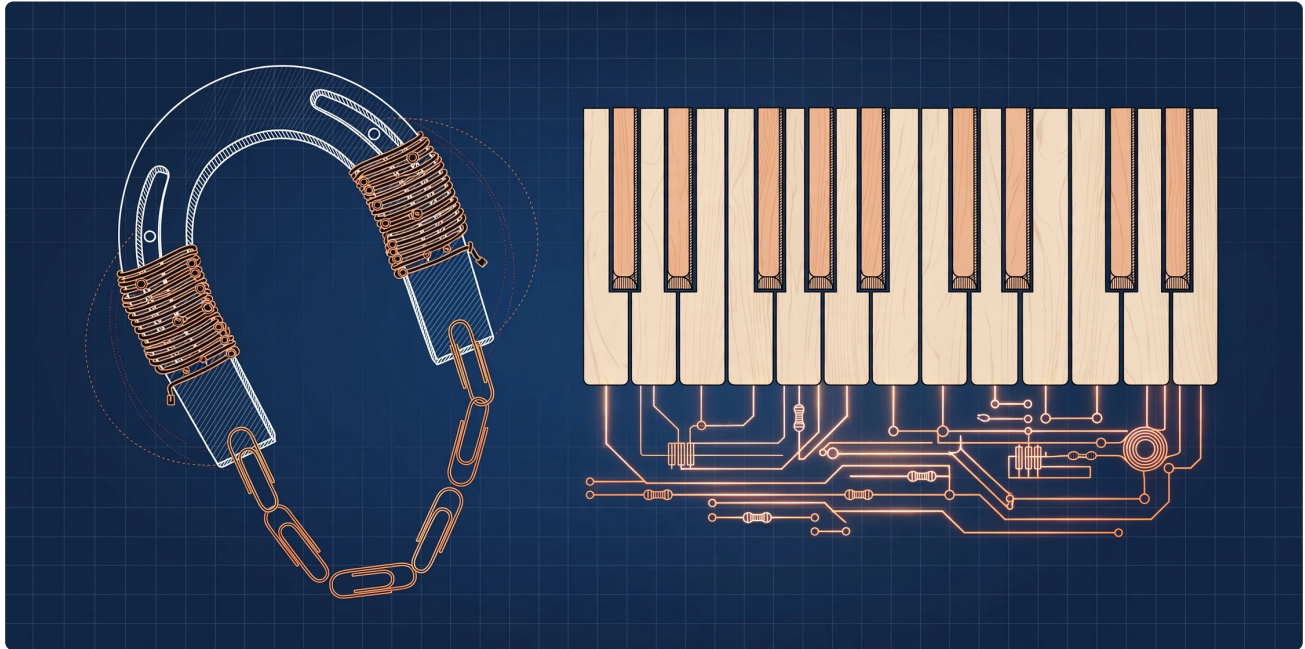
Week 4 — Bernoulli Wind Lab

- **Big question:** What pushes a wing up?
- **Key idea:** Fast air pushes less than slow air — and a wing also shoves air downward. Both effects push the wing up.
- **Build:** Venturi and airfoil demos with a PC fan; make paper lift.
- **Show what you learned:** Draw the air going over the wing and show where it pushes. *Hardware ~\$29–79.*

Week 5 — Cam-Follower Engine

- **Big question:** How does a shape become a motion?
- **Key idea:** A bumpy wheel can push things up and down in a pattern — even a square one (badly).
- **Build:** Swappable birch cams (round, heart-shaped, and one square "bad example") with a crank.
- **Show what you learned:** Demonstrate each cam and vote on which motion is smoothest — and why the square fails. *Hardware ~\$25–59.*

Unit 2 · Sparks and Switches — Electricity and Circuits (Weeks 6–10)



Standards: MS-PS2-3 (electric/magnetic force strength), MS-PS4-3 (digitized signals, for logic/synth weeks), 3-5-ETS1-1 to -3 / MS-ETS1-1 to -4 (engineering design)

Week 6 — Electromagnet Lab

- **Big question:** How do you make a magnet you can turn off?
- **Key idea:** Electricity flowing in loops makes magnetism; more loops, stronger pull.
- **Build:** Nail electromagnet wired ... (continued on the next page, p. 8a)
- **Show what you learned:** A bar chart of turns vs. paperclips. *Hardware* ~\$15–40.

Week 7 — Piano Circuit Machine

- **Big question:** What makes a note a note?
- **Key idea:** Fast buzzes sound high, slow buzzes sound low — pitch is just speed.
- **Build:** Birch 8-key piezo piano; play a real tune.
- **Show what you learned:** Perform a short melody for the class. *Hardware* ~\$15–65.

p. 8a — continued from p. 8

Continued from p. 8

- Build: Nail electromagnet wired through a momentary push-button (press ≤ 5 s, rest ≥ 30 s; never touch the coil to check heat — an adult disconnects anything warm); count paperclips lifted vs. coil turns.

Week 8 — Binary Logic Gates Board

- Big question: How does a computer think in yes and no?

- **Key idea:** Everything computers do starts with AND, OR, and NOT.
- **Build:** Birch switch-and-LED board; light up the truth tables.
- **Show what you learned:** Demonstrate each gate and explain it like you're teaching a friend.
Hardware ~\$20–67.

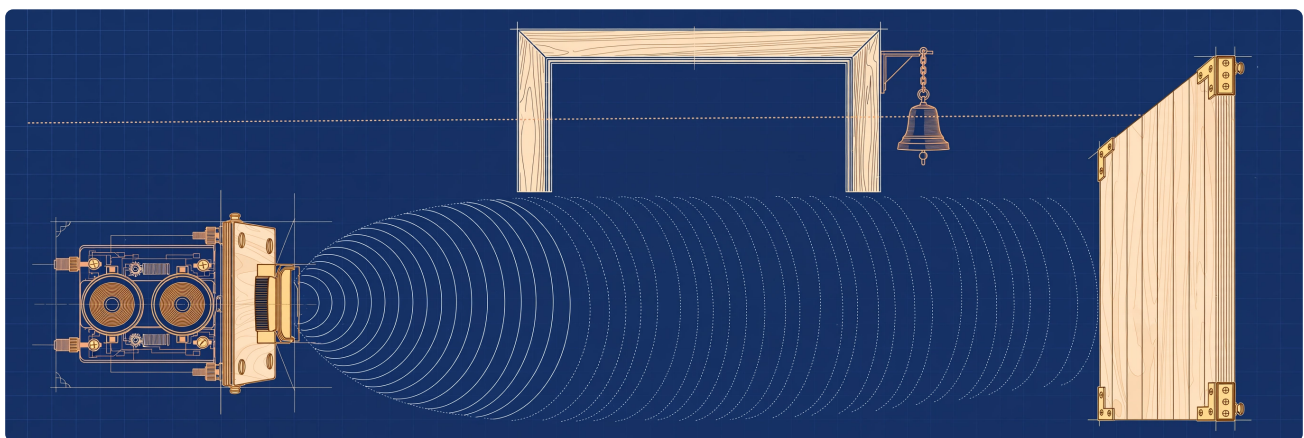
Week 9 — Capacitive Touch Synth

- **Big question:** How does a screen know you touched it?
- **Key idea:** Your body holds a tiny electric charge — sensors can feel it without pressing.
- **Build:** Birch touch pads that play tones when touched (no pushing).
- **Show what you learned:** Play a tune by hovering, not pressing. *Hardware ~\$21–56.*

Week 10 — Diffraction Spectroscope

- **Big question:** Can you catch a rainbow in a tube?
- **Key idea:** Light is made of colors; a CD's grooves split them apart by diffraction — the same phenomenon Max von Laue used with X-rays to reveal the structure of crystals.
- **Build:** Birch tube spectroscope with a CD grating; look at lamps and the sky.
- **Show what you learned:** Draw the spectra of three different light sources and spot the differences.
Hardware ~\$8–43.

Unit 3 · Super Senses — Detecting the World (Weeks 11–15)



Standards: MS-PS4 (waves and information), MS-ETS1 (engineering design)

Week 11 — IR Tripwire Doorbell

- **Big question:** Can you make an alarm out of invisible light?
- **Key idea:** Infrared is light you can't see; breaking the beam means something passed.
- **Build:** Birch door-frame mounts; first a short-range beam, then a long-range doorway version.
- **Show what you learned:** Demo the finished doorbell — walk through it and make it ring. *Hardware ~\$16–80.*

Week 12 — Ultrasonic Rangefinder Lab

- **Big question:** How do bats see in the dark?
- **Key idea:** Shout (in ultrasound) and time the echo — halve the round-trip time, multiply by the speed of sound, and that's the distance.
- **Build:** HC-SR04 ranger on a birch stand with a live distance display.
- **Show what you learned:** Measure five mystery distances and check with a tape measure. *Hardware ~\$18–73.*

Week 13 — Solar Tracker

- **Big question:** Can a machine follow the sun?
- **Key idea:** Compare brightness on four sensors, tilt toward the brightest — simple rules, smart behavior.
- **Build:** Birch gimbal that pans and tilts toward light.
- **Show what you learned:** Shine a flashlight around it and watch it follow. *Hardware ~\$21–102.*

Week 14 — Weather Station

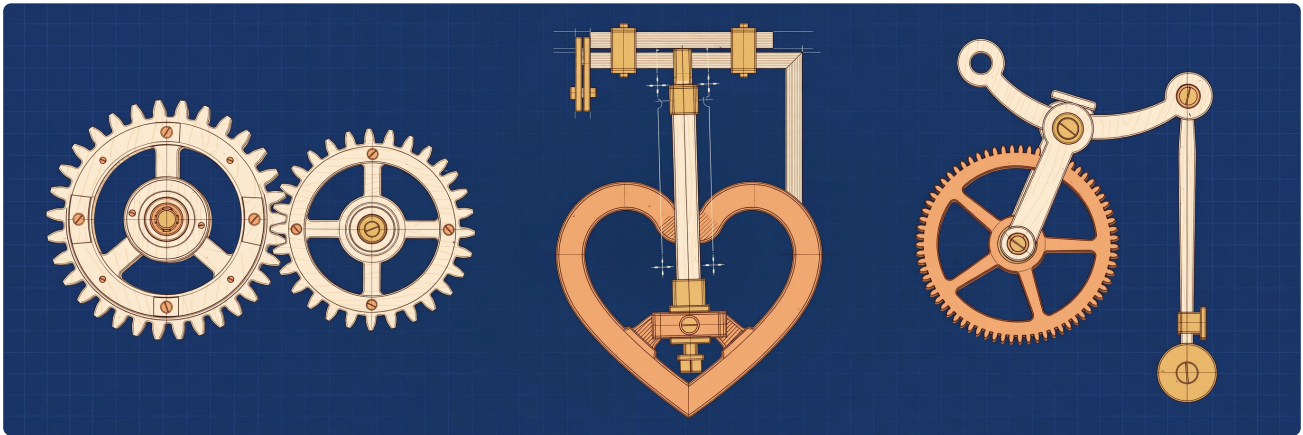
- **Big question:** What's the weather doing when you're not looking?
- **Key idea:** Measuring over days beats guessing once — that's what data logging is.
- **Build:** Birch-enclosure weather station; run it for a full week.
- **Show what you learned:** Present one discovery from your week of data ("our classroom is driest at 2pm"). *Hardware ~\$25–102.*

Week 15 — Desk Load-Cell Scale

- **Big question:** How do you know a scale is telling the truth?
- **Key idea:** Scales need to be taught what weight means — that's calibration.
- **Build:** Digital scale; teach it with known weights, then weigh mysteries.

- **Show what you learned:** Weigh three mystery objects and reveal how close you got. *Hardware ~\$18–100.*

Unit 4 · Machines in Motion (Weeks 16–20)



Standards: MS-PS2 (motion and forces), MS-ETS1 (engineering design)

Week 16 — Stepper Clock Escapement

- **Big question:** How do you turn electricity into exact time?
- **Key idea:** Tiny electric steps add up to a ticking minute hand.
- **Build:** Birch clock face driven by a stepper motor.
- **Show what you learned:** Set it against a real clock — how close is it after an hour? *Hardware ~\$22–77.*

Week 17 — POV LED Spinner

- **Big question:** Why do spinning lights draw pictures?
- **Key idea:** Your eyes hold onto light for a split second — spin LEDs fast and pictures appear.
- **Build:** Enclosed birch spinner with synced LED columns.
- **Show what you learned:** Show your pattern in a darkened room. *Hardware ~\$66–101.*

Week 18 — Tilt Maze Labyrinth

- **Big question:** Can you beat gravity at its own game?
- **Key idea:** Tilting the board is steering with gravity.
- **Build:** Dual-servo tilt maze; guide the ball home.

- **Show what you learned:** Class tournament — fastest clean run wins. *Hardware ~\$35–88.*

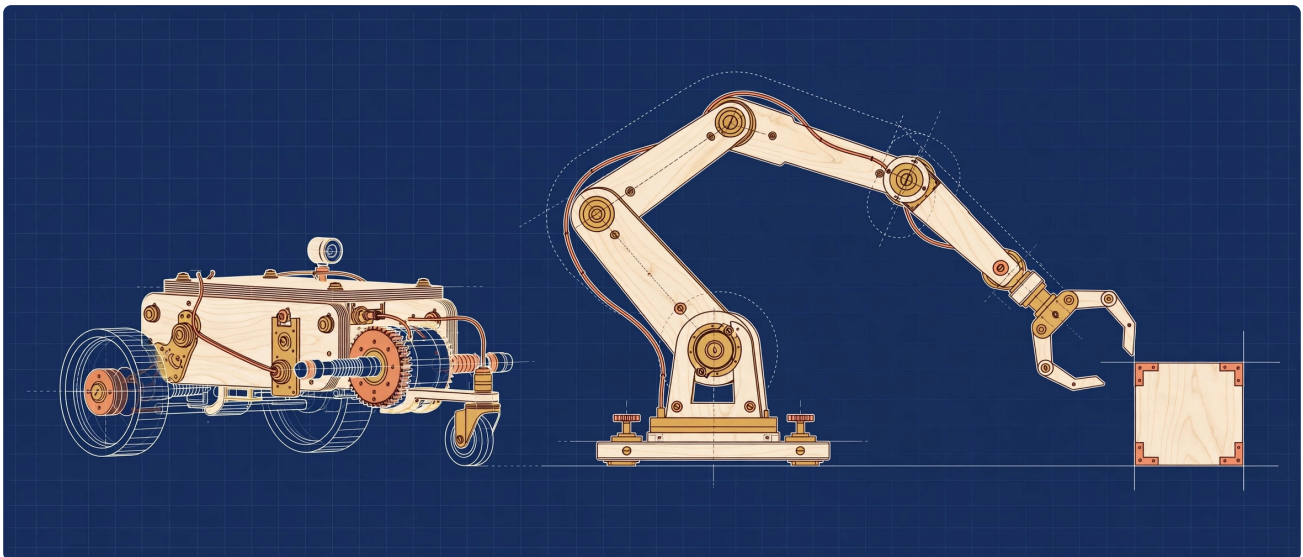
Week 19 — Pneumatic Soft Gripper

- **Big question:** How do you pick up an egg without breaking it?
- **Key idea:** Air pushes equally everywhere (Pascal) — soft squeezes where hard would crack.
- **Build:** Syringe-powered soft gripper on a birch mount.
- **Show what you learned:** The egg challenge: lift it, move it, set it down unbroken. *Hardware ~\$14–48.*

Week 20 — Strain-Gauge Beam Lab (gentle version)

- **Big question:** How bendy is this stick, exactly?
- **Key idea:** Everything bends a little — measuring how much tells you what it's made of.
- **Build:** Clamped birch beam; hang weights, measure the bend.
- **Show what you learned:** A simple chart: more weight, more bend — predict the next one before hanging it. *Hardware ~\$11–82.*

Unit 5 · Robots That React (Weeks 21–25)



Standards: MS-ETS1 (engineering design), MS-PS2 (motion and forces)

Week 21 — Light-Following Robot

- **Big question:** Can a robot with no brain still chase light?

- **Key idea:** Wire sensors straight to motors and lifelike behavior just appears.
- **Build:** Birch chassis with light sensors; try "seeker" and "scaredy-cat" wirings.
- **Show what you learned:** Demo both behaviors and explain the wiring trick. *Hardware ~\$31–183.*

Week 22 — Birch Differential Rover

- **Big question:** How do tanks turn without a steering wheel?
- **Key idea:** Spin one side faster than the other and the whole thing rotates.
- **Build:** Laser-cut rover chassis with twin motors.
- **Show what you learned:** Drive a square course — no steering allowed. *Hardware ~\$42–149.*

Week 23 — Line-Following Rover

- **Big question:** How does a robot follow a line with no map?
- **Key idea:** See the line, steer toward it, repeat hundreds of times a second.
- **Build:** IR-sensor line follower; tune it until it completes the track.
- **Show what you learned:** Race day on the class track. *Hardware ~\$50–157.*

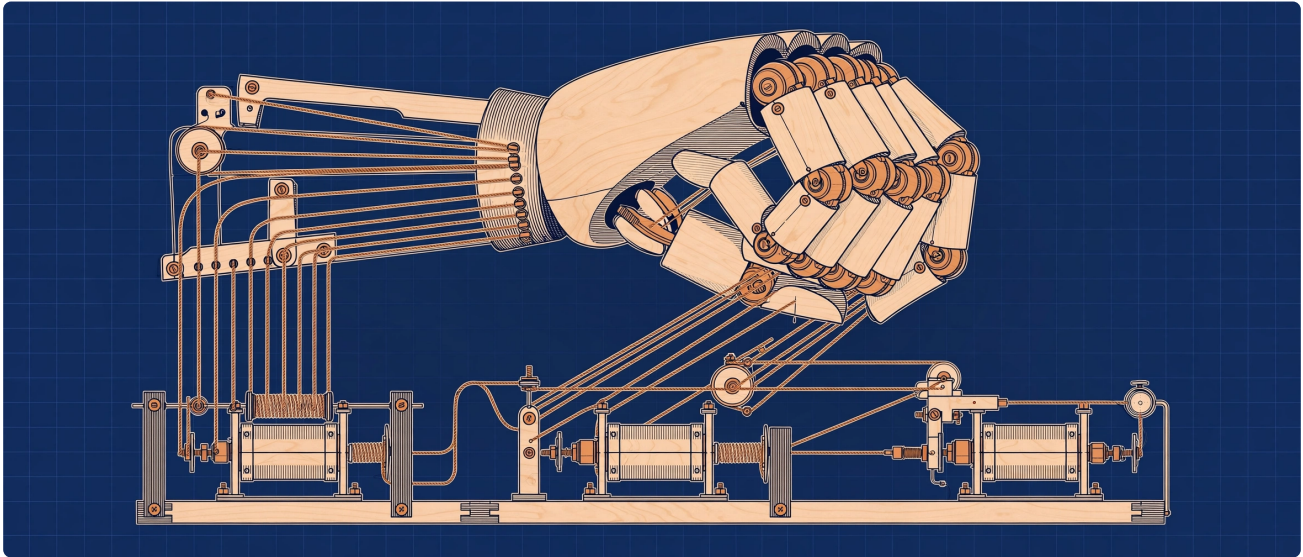
Week 24 — Color-Sort Chute

- **Big question:** How would you automate a recycling plant?
- **Key idea:** See the color, flip the flap — a tiny factory.
- **Build:** Color-sensor sorting chute with diverter flaps.
- **Show what you learned:** Sort 20 mixed items; count the mistakes. *Hardware: see pack BOM.*

Week 25 — 3-DOF Plywood Arm

- **Big question:** How many joints does it take to grab something?
 - **Key idea:** Shoulder, elbow, wrist — three moves reach almost anywhere on the desk.
 - **Build:** Laser-cut robot arm with three servos.
 - **Show what you learned:** Pick-and-place relay: move three objects into the target zone. *Hardware ~\$32–125.*
-

Unit 6 · Bring It to Life — Animatronics Finale (Weeks 26–30)



Standards: MS-ETS1 (engineering design), 3–5-ETS1 (design process)

Week 26 — Gyro Leveling Platform

- **Big question:** How do drones stay level in the wind?
- **Key idea:** Feel the tilt, fix the tilt, repeat — that's a feedback loop.
- **Build:** Self-leveling tray; try to unbalance it.
- **Show what you learned:** Tilt it every direction — does it recover every time? *Hardware ~\$34–128.*

Week 27 — Servo Expression Face

- **Big question:** How many motors does it take to look surprised?
- **Key idea:** Eyebrows + eyes + jaw, timed together, read as a feeling.
- **Build:** Birch face with brow, eye, and jaw servos; program three expressions.
- **Show what you learned:** Expression charades — the class guesses the feeling. *Hardware ~\$38–111.*

Week 28 — Animatronic Mascot Head

- **Big question:** What makes a machine feel alive?
- **Key idea:** Coordinated motion beats more motion — jaw and eyes together sell it.
- **Build:** Original birch mascot head; choreograph a 10-second "alive" sequence.

- **Show what you learned:** Perform your sequence; class votes most lifelike. *Hardware ~\$36–109.*

Week 29 — Remix Workshop

- **Big question:** What would you build if you started over?
- **Key idea:** Real engineers iterate — take any build from this year further.
- **Build:** Student's choice: extend, combine, or rebuild any previous kit.
- **Show what you learned:** Present the remix: what changed and why it's better.

Week 30 — Finale: Animatronic Hand + Showcase

- **Big question:** Can you copy the most complex machine you own?
- **Key idea:** Five fingers, five tendons, one controller — the flagship Laue Labs apprenticeship.
- **Build:** (Two sessions.) Laser-cut birch hand; five independently driven digits.
- **Show what you learned:** Family showcase night — demonstrate two grips and explain how the tendons work. Keep the hand. *Hardware ~\$42–148.*

Curriculum A — Assessment & standards

Build journals (the core assessment): Each week, students record: what they built (sketch or photo), what they measured (a simple table or chart), and one sentence answering the big question. Graded on honesty and completeness — failed trials count; made-up data doesn't.

Demo days: Each unit ends with students demonstrating their builds. Working beats pretty.

Showcase (Week 30): Families invited; ... (continued on the next page, p. 15a)

Standards alignment: Units map to NGSS 3–5-ETS1 and MS-ETS1 (engineering design), MS-PS2 (motion and forces), MS-PS3-3 (thermal energy device design, weather/solar weeks), and MS-PS4 (waves) as noted per unit. Full crosswalk available on request.

Budget note: Per-kit hardware runs ~\$8–183; equipping one build station for all 30 weeks runs roughly \$1,000–2,800 in parts, with core electronics (boards, servos, sensors, tools) reused across the year.

p. 15a — continued from p. 15

Continued from p. 15

Showcase (Week 30): Families invited; students present their hand and one favorite build from the year.
Safety: Z87+ (ANSI/ISEA Z87.1) impact-rated safety glasses (e.g., 3M SecureFit SF201AF) for everyone in the room whenever anything launches, breaks, spins, or is cut.

Appendix A — Glossary

Term	Definition
Apogee	The highest point of a rocket's flight; the flight computer finds it as the altitude of minimum barometric pressure.
Ballista	An ancient torsion-powered projectile launcher; here, a tabletop model for studying projectile motion.
Bernoulli's principle	Faster-moving fluid exerts lower pressure; one contributor to wing lift (the other is downward deflection of air).
Braitenberg vehicle	A robot whose sensors wire directly to its motors, producing lifelike behavior with no programmed "brain."
Calibration	Teaching an instrument what its readings mean, using known references.
Cam	A shaped wheel that converts rotation into a patterned push-pull motion in a follower.
Capacitive sensing	Detecting touch by the tiny electric charge the human body carries; no pressure required.
Carnegie unit	The traditional U.S. high-school credit standard, nominally 120 hours of instructional contact time (e.g., 1 h × 5 days × 24 weeks).
Diffraction	The spreading of waves around obstacles or through gratings; Max von Laue used X-ray diffraction to reveal crystal structure (Nobel Prize, 1914).
Drag	Air resistance opposing motion, growing with the square of speed: $F = \frac{1}{2}\rho v^2 C_d A$.
Feedback loop	Sense, compare to a target, correct, repeat; the basis of the self-leveling platform and all control systems.
Grating equation	$d \cdot \sin\theta = m\lambda$; relates a grating's line spacing to the angles at which colors appear.
Gyroscope	A sensor that measures rotation rate; integrating it gives tilt angle but drifts, so the platform fuses it with the accelerometer's gravity reference (complementary filter) to sense tilt.
Load cell	A sensor that converts force into an electrical signal; the heart of a digital scale.
MOSFET	A transistor switch that lets a small signal control a large current, e.g., driving an electromagnet.
Residuals	The leftover differences between measured data and a fitted model; their pattern diagnoses bad calibrations.

Term	Definition
Servo	A small motor that moves to a commanded angle and holds it.
Strain gauge	A sensor whose electrical resistance changes as it stretches; used to measure tiny bends.
Thrust	The force a motor produces; average thrust $\times$ burn time gives the impulse that sets burnout velocity.
Truth table	The complete list of inputs and outputs for a logic gate or circuit.
Ultrasonic ranging	Distance from echo time: $d = v \cdot t/2$, halved because sound travels there and back.
Uncertainty	The honest $\pm$ range on a measurement; every reported result in this program carries one.
Young's modulus	A material's stiffness, extracted here from the slope of beam-deflection vs. load.

Appendix B — Master Hardware Index

Approximate hardware cost per build station (electronics core reused across weeks). Packs are digital (guide, cut files, code, lessons); hardware is sourced per each pack's bill of materials.

Kit	Hardware (approx.)
Animatronic Hand	\$42–148
Animatronic Mascot Head	\$36–109
Ballista Physics Lab	\$19–61
Bernoulli Wind Lab	\$29–79
Binary Logic Gates Board	\$20–67
Birch Differential Rover	\$42–149
Bridge Load Lab	\$14–58
Cam-Follower Engine	\$25–59
Capacitive Touch Synth	\$21–56
Color-Sort Chute	see BOM

Kit	Hardware (approx.)
Desk Load-Cell Scale	\$18–100
Diffraction Spectroscope	\$8–43
Electromagnet Lab	\$15–40
Gear Ratio Lab	\$16–71
Gyro Leveling Platform	\$34–128
IR Tripwire Doorbell	\$16–80
Light-Following Robot	\$31–183
Line-Following Rover	\$50–157
Piano Circuit Machine	\$15–65
Pneumatic Soft Gripper	\$14–48
POV LED Spinner	\$66–101
Rocket Flight Computer & Telemetry Lab	see BOM
Servo Expression Face	\$38–111
Solar Tracker	\$21–102
Stepper Clock Escapement	\$22–77
Strain-Gauge Beam Lab	\$11–82
Tilt Maze Labyrinth	\$35–88
Ultrasonic Rangefinder Lab	\$18–73
Weather Station	\$25–102
3-DOF Plywood Arm	\$32–125

Appendix C — Standards Alignment (Curriculum A)

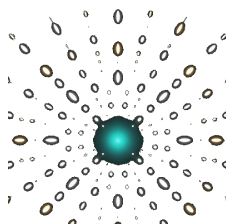
Unit	Weeks	NGSS
	1–5	

Unit	Weeks	NGSS
1 · Push, Pull & Play — Motion and Structures		MS-PS2 (motion and forces), MS-ETS1 (engineering design)
2 · Sparks and Switches — Electricity and Circuits	6–10	MS-PS2-3, MS-PS4-3, MS-ETS1
3 · Super Senses — Detecting the World	11–15	MS-PS4 (waves and information), MS-ETS1
4 · Machines in Motion	16–20	MS-PS2, MS-ETS1
5 · Robots That React	21–25	MS-ETS1, MS-PS2
6 · Bring It to Life — Animatronics Finale	26–30	MS-ETS1, 3–5-ETS1 (design process)

Full performance-expectation crosswalk available from Laue Labs on request.

Document History

Version	Date	Notes
1.0	2026-10-12	Initial release · v1.1 (2026-10-13): safety & technical corrections



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Build instructions and pack contents are proprietary to their licensed
Laue Labs packs; this document is the curriculum wrapper and does not reproduce them.

Safety & Corrections (v1.1)

About this page

Version 1.1 (2026-10-13). The items below were corrected after technical review. Where a page in this document says something different, this page governs.

1. Eye protection

ANSI/ISEA Z87.1-marked (Z87+) impact-rated safety glasses, e.g., 3M SecureFit SF201AF, worn by everyone in the room (students, teachers, observers) whenever anything launches, breaks, spins, is cut, is soldered, or is under spring/elastic tension. Ordinary eyeglasses and non-Z87+ 'safety' glasses do not qualify. Do not substitute unmarked glasses.

2. Electromagnet (Week 6): near-short burn hazard

This coil is close to a short circuit on a D cell (several amps). Connect it ONLY through a momentary push-button (one per team). Hold for ≤ 5 seconds per lift, then let it cool for ≥ 30 seconds. Never test heat by touching the coil, the nail, or the battery. If any part feels warm through the holder, or smells hot, an adult disconnects it and the session continues on a fresh cell. Adults handle any coil that has been powered for more than 5 seconds. Optional: a 1 Ω , 5 W series resistor caps the current near 1 A and makes the activity safe for under-10s. Students: press for 5 seconds, then rest. Never touch the coil to see if it's hot — tell your teacher.

7. Audience

Curriculum A is for students ages 8–14; Curriculum B is for high-school students in grades 9–12 (Algebra I required, concurrent Geometry or higher).

8. Credit justification (Curriculum B)

1.0 credit is awarded on a total-engaged-work basis: 120 documented hours (45 supervised lab + 75 structured independent pre-lab, analysis, and reporting), consistent with common homeschool/independent-school transcript practice (120–150 hours per credit). This exceeds the traditional Carnegie contact-hour definition only when independent work counts; schools that require 120 contact hours should award 0.5 credit or add supervised time. For reference, 45 supervised lab hours is equivalent to the contact time of a 1-credit-hour college laboratory course. Glossary — Carnegie unit: the traditional U.S. high-school credit, nominally 120 hours of instructional contact time (e.g., 1 h $\times$ 5 days $\times$ 24 weeks).

16. Curriculum A standards

Unit 2 (Sparks and Switches): MS-PS2-3 (electric/magnetic force strength), MS-PS4-3 (digitized signals, for logic/synth weeks), 3-5-ETS1-1 to -3 / MS-ETS1-1 to -4 (engineering design). Weather/solar weeks: MS-PS3-3 (thermal energy device design).

19. Gyroscope (glossary)

A sensor that measures rotation rate; integrating it gives tilt angle but drifts, so the platform fuses it with the accelerometer's gravity reference (complementary filter) to sense tilt.