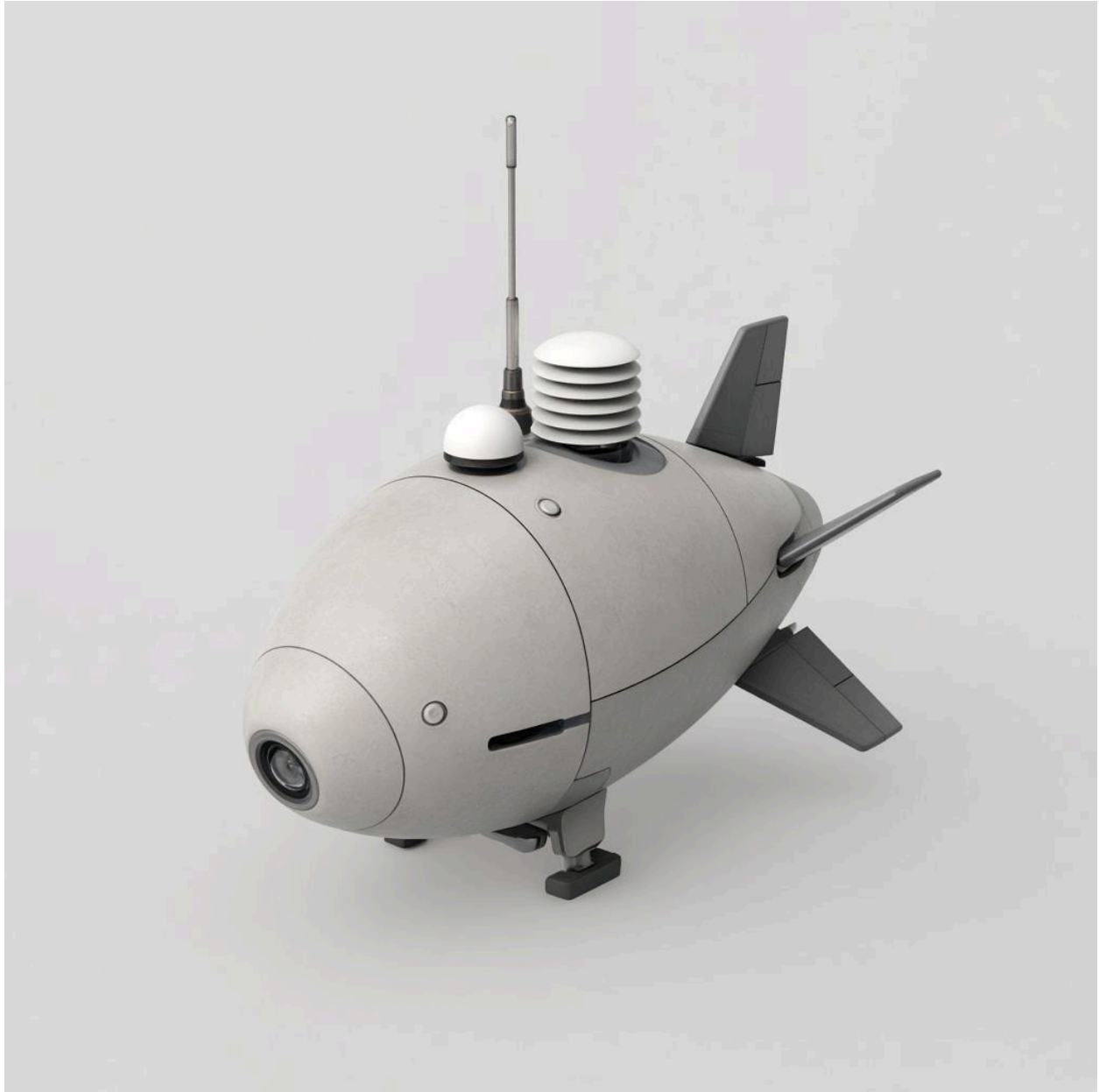


Robot Weather Pod

Teacher Guide · Grade 3

Hearts Invention Lab STEM Curriculum · Reverse Engineering Series · Simple systems and forces



A small, sealed, uncrewed robot weather pod with a tough rounded shell

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How to use this guide

Safety rule first: No people ever ride a tornado. When there is a tornado warning, people go to a certified safe room or follow local emergency instructions. Only robot pods go into storms.

This guide has the Grade 3 unit. Each unit has 4 or 5 lessons. Students reverse-engineer the Robot Weather Pod: they explode it into parts, read each part's job, rebuild it and name their own version. Each unit then adds a hands-on activity using household and classroom items only.

- **Digital-only.** This curriculum is sold as printable, downloadable files. No kits or materials packs exist or are needed.
- **Facts and sources.** Every research fact carries a source tag [S#]. Parts or claims with no published source are marked “design reasoning, no source” (or “design idea, no source”) so students can see the difference between evidence and design ideas.
- **Practice values.** Some maths problems in grades 9–12 use clearly labelled practice values (PV). These are made-up numbers for the exercise, not source facts.
- **Standards.** NGSS and CCSS codes are given with paraphrased descriptions. Check them against your state's standards.
- **The app.** heartsinventionlab.com/app/ (Ages 5+). Open Reverse Engineer, then Robot Weather Pod. Lumet, the app's crystal guide, leads the teardown (Basic mode), the rebuild, naming your version and the material quiz (Advanced mode).
- **License.** Licensed to the buyer only. Not for resale or public posting. A Family & Classroom License covers one home or one classroom; a School Site License covers every teacher at one school building.

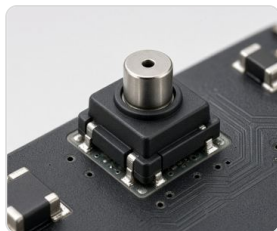
The Robot Weather Pod at a glance

The Robot Weather Pod is a small, sealed, uncrewed pod that measures a storm from the inside and keeps every sample sealed until scientists open it. It borrows real parts from tornado ground probes [S1], dropsondes dropped from aircraft [S3, S4], airbag landings on Mars [S8, S9] and sample-return capsules [S7]. **Honest note:** a pod meant to be carried by a tornado has never been built or tested. This is a concept made of real, tested parts. In the app it comes apart in 6 layers:

1. Outside (storm shell)
2. Sensors (pressure sniffer, weather feelers, GPS wind tracker, spin and tumble sensor)
3. Samples (sample scoop, sample safe)
4. Radio and memory (storm radio, data memory vault)
5. Landing (drogue chute, main parachute with cut-away, bounce bags)
6. Power (power pack)



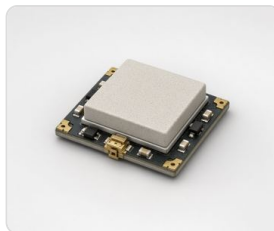
1. Storm shell



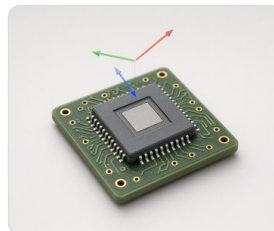
2. Pressure sniffer



3. Weather feelers



4. GPS wind tracker



5. Spin and tumble sensor



6. Storm radio



7. Data memory vault



8. Drogue chute



9. Main parachute with cut-away



10. Bounce bags



11. Power pack



12. Sample scoop



13. Sample safe

Grade-band progression

Band	Focus
K-2	Weather watching, sounds and signals, keeping samples safe and dry
3-5	Weather data tables, parachutes and air resistance, energy in a landing, air as matter
6-8	Sensors and sampling rates, designing a landing that protects a sample, forces and hazards
9-12	Impulse and airbags, gas pressure and batteries, human limits and biosafety packaging, full design review

Grade 3: Weather Data and Parachutes

4 lessons · about 140 minutes in total · © 2026 Hearts Invention Lab

Safety rule first: No people ever ride a tornado. When there is a tornado warning, people go to a certified safe room or follow local emergency instructions. Only robot pods go into storms.

Overview

Third graders collect a week of weather data in tables and graphs, then study the pod's two parachutes. They build coffee-filter parachutes and test how canopy size changes fall time, a fair test of balanced and unbalanced forces.

Learning objectives

Students will:

- Record and graph weather data to describe typical weather.
- Explain that air pushes up on a falling parachute.
- Run a fair test changing only one thing.
- Explain why the pod has a small drogue chute and a main chute.

Standards alignment

Framework	Code	What students do (paraphrased)	Status
NGSS	3-ESS2-1	Represent data in tables and graphs to describe typical weather in a season (paraphrased).	Aligned
NGSS	3-PS2-1	Plan an investigation of balanced and unbalanced forces on an object's motion (paraphrased).	Aligned
NGSS	3-ESS3-1	Make a claim about a design solution that reduces the impact of a weather hazard (paraphrased).	Suggested alignment
CCSS	3.MD.B.3	Draw scaled picture and bar graphs.	Aligned
CCSS	3.MD.A.1	Tell and measure time intervals in minutes and seconds.	Aligned
CCSS	W.3.7	Do short research projects.	Suggested alignment

"Aligned" means the unit directly addresses the performance expectation. "Suggested alignment" means a partial or supporting fit for the teacher to confirm.

Lessons and timing

Lesson 1: Explore the pod (40 min)

1. Safety rule. Explode and take apart the pod; list the sensor parts.
2. Read: real dropsondes record pressure, temperature and humidity twice a second [S3].

Lesson 2: Weather station week (15 min a day)

FREE SAMPLE · © 2026 Hearts Invention Lab · Robot Weather Pod, Grade 3 · Free to download and print for your own home or classroom. Not for resale.

1. Record temperature (thermometer or forecast), cloud cover and wind (streamer) daily.

2. Make a table and bar graph on Friday.

Lesson 3: Parachute fair test (hands-on) (45 min)

1. Build parachutes with small and large canopies (see hands-on).
2. Drop 3 times each; time with a stopwatch; record the average.

Lesson 4: Two chutes, one landing (40 min)

1. Read the drogue and main parachute cards.
2. Explain: the small chute stops tumbling; the big one slows the fall; the release lets go at landing.

Materials (household and classroom items only)

- Coffee filters or tissue paper; string or thread; tape
- Paper clips or washers (the “pod”)
- Stopwatch or phone timer
- Outdoor thermometer if available; a ribbon streamer for wind
- Graph paper

Nothing in this unit needs a purchased kit.

Hands-on activity: Parachute Fair Test

1. Make two parachutes: one coffee filter, and two filters taped edge to edge (bigger canopy). Use the same string length and the same 3 paper clips.
2. Stand on a safe, steady spot (not a chair) and drop each from the same height, such as a raised arm.
3. Time 3 drops each; find the average.
4. Which fell slower? Why? (More air pushes up on a bigger canopy.)
5. Link it: real dropsondes use a square-cone chute and fall about 11.5 m/s near sea level [S4].

In-app activity (Hearts Invention Lab app, Ages 5+)

Lumet, the app’s crystal guide, walks students through each step. The app is free to open at heartsinventionlab.com/app/.

1. Open Reverse Engineer, then Robot Weather Pod. Read Lumet’s safety rule first.
2. Explode the pod; read every part card.
3. Basic mode: take it apart by layer and rebuild it; name your version.
4. Advanced mode: match each part to its material.

Every part: why this material, what it does, how it is built

Part (material)	Why this material was chosen	What the part does	How it is assembled in real life
Storm shell (Polycarbonate or fibreglass shell, foam lining)	Impact-resistant plastic shrugs off hail. A real tornado probe used a low shape so wind could barely lift it. [S1]	A tough, rounded, sealed body against rain, hail and grit.	Shell halves are sealed together with a foam lining inside. (design idea, no source)

Part (material)	Why this material was chosen	What the part does	How it is assembled in real life
Pressure sniffer (Silicon pressure sensor behind vent holes)	Silicon sensors are tiny and can feel small pressure changes. (design idea, no source)	Measures air pressure, which drops sharply in a tornado's core. [S1]	Mounted behind small vent holes. (design idea, no source)
Weather feelers (Platinum-wire and thin-film sensors in a shield)	Thin sensors react quickly as the air changes. (design idea, no source)	Measures temperature and humidity, twice a second on real dropsondes. [S3]	Placed in a ventilated shield. (design idea, no source)
GPS wind tracker (GPS receiver and antenna)	GPS can track position and speed. [S3]	Works out the wind from how the pod is pushed sideways. [S3]	A receiver and antenna with a clear view of the sky. (design idea, no source)
Spin and tumble sensor (Accelerometer and gyroscope chip)	Motion chips sense spinning and bumps. (design idea, no source)	Tells the pod when it is safe to open its parachute.	Mounted on the main board. (design idea, no source)
Storm radio (Low-power radio, flexible antenna)	Radio waves carry data through storm clouds. [S3]	Sends live data and works as a homing beacon after landing.	Low-power radio with a flexible antenna. (design idea, no source)
Data memory vault (Flash memory, shock-mounted, potted in foam)	Flash memory keeps data with no power. [S1]	Saves every reading in case the radio signal is lost.	Shock-mounted and sealed in foam, next to the sample safe. (design idea, no source)
Drogue chute (Nylon fabric, strong fibre lines)	Nylon is light and strong. [S3]	A small first chute that stops tumbling and points the pod the right way.	Packed so it opens first. [S3]
Main parachute with cut-away (Nylon canopy, fibre risers, electric release)	A nylon canopy slows the pod; an electric release cuts it free. [S6, S7]	Slows the pod, then lets go on touchdown so wind can't drag it.	The release sits between the risers and the pod and is triggered by the impact sensor. [S7]
Bounce bags (Woven fibre fabric over inner bladders)	Layers of strong woven fabric survive bouncing on rocks. [S8]	Wrap the pod's centre in a cushion so data and samples survive.	Folded bags fill from a small gas generator just before landing. [S8]
Power pack (Sealed rechargeable lithium pack, kept warm)	Lithium packs store a lot of energy for their size. [S3]	Runs the sensors, radio and release.	Sealed, shock-mounted and kept warm, because this kind must not be charged when freezing. [S10]
Sample scoop (Stainless inlet, fine filter, one-way valve, vacuum canisters)	Stainless steel is clean and does not rust. [S11]	Lets storm air, rain and dust in through a one-way valve that snaps shut.	A filtered inlet leads to small vacuum canisters. [S11]
Sample safe (Screw-sealed vials, absorbent pad, sealed case, crush-proof cassette)	Layers of packing protect samples, like real lab shipping. [S12]	Locks each sample in its own sealed vial.	Vials, absorbent padding, a sealed inner case and a crush-proof outer cassette. [S12]

Tags in brackets [S#] point to the Sources list at the end of this guide. "No source" marks a design idea from the invention file that no published source backs up yet.

Real-world assembly sequence

This pod has never been built or tested. The steps below borrow from real weather probes, dropsondes and space capsules. (design idea)

1. Build the circuit board with the pressure, weather and motion sensors. *[design reasoning, no source]*
2. Seal the memory vault and put it next to the sample safe at the centre. *[design reasoning, no source]*
3. Fit the warm, sealed battery. *[S10]*
4. Fit the scoop, filter, one-way valve and empty canisters. *[S11]*
5. Pack the sample vials in layers. *[S12]*
6. Pack the drogue chute, the main chute with its release, and the airbags. *[S3, S7, S8]*
7. Seal the shell and test the radio. *[S1, S3]*

The source files do not give a factory build order for this pod. The order above is design reasoning: protect the data and samples at the centre first, then add recovery parts, then seal the shell. Students may argue for a different order.

Vocabulary

Word	Meaning
Data	Information collected to answer a question.
Table	Rows and columns that hold data.
Air resistance	Air pushing against something moving through it.
Drogue	A small first parachute that steadies a falling object.
Fair test	Changing only one thing so the result is trustworthy.

Teacher's background (cited facts)

F8 explains the drogue. The parachute test models air resistance; it doesn't reproduce real fall speeds.

- Research dropsondes measure pressure, temperature and humidity twice a second (2 Hz) as they fall. [S3, S4]
- Dropsondes use a square-cone parachute that reduces the opening shock, holds them steady with almost no swinging, and gives a fall speed of about 11.5 m/s near sea level. [S3, S4]
- Safety investigators warn that a parachute still attached after landing can reopen in wind and drag the aircraft. NASA's OSIRIS-REx sample capsule was designed to cut its main parachute on touchdown so it would not be dragged, lowering the risk to the sample container. [S6, S7]
- Honest status: a pod meant to be carried by a tornado has never been built or tested. Each part copies a real, tested device, but the whole pod is a concept.

Discussion questions

1. What was the typical weather this week?
2. Why did the bigger parachute fall more slowly?
3. Why does the pod let go of its parachute at landing?
4. What made our test fair?

Assessment

1. What did your graph show about this week's weather?
2. Which parachute fell slower and why?
3. What does the drogue chute do?
4. Why cut the main parachute free at landing?

Answer key

1. Accept answers backed by the class graph.
2. The bigger canopy, because more air pushed up on it.
3. Stops tumbling and points the pod the right way.
4. So wind can't drag the pod and shake or crack the sample safe [S6, S7].

Rubric

Criterion	Not yet	Getting there	Got it!
Data and graph	Missing	Table or graph	Table and labelled graph
Fair test	Changed many things	Mostly fair	Only canopy size changed
Parachute jobs	None	One chute explained	Both chutes and the release

Differentiation and extension

- **Support:** Provide a ready-made data table and a parachute template.
- **Challenge:** Test a third canopy size and predict its time before dropping.
- **Extension:** Compare your week's data with a weather report for the same days.

Safety note

Drop from standing height only; never climb on chairs or tables. Keep string away from necks.

Sources

All facts in this guide come from the Hearts Invention Lab Robot Weather Pod invention file and app data. Every link below was fetched and checked against its text on 2026-10-20 (a few sites block automated checks; those are noted):

- **[S1]** Lee, Samaras & Young, “Pressure measurements at the ground in an F-4 tornado,” AMS conference paper, 2004. <https://ams.confex.com/ams/pdfpapers/81700.pdf>
- **[S2]** National Weather Service Sioux Falls, “June 24, 2003 tornado” (F4 rating). <https://www.weather.gov/fsd/20030624-tornadosamaras>
- **[S3]** NCAR Earth Observing Laboratory, “AVAPS Dropsonde System”. https://www.eol.ucar.edu/observing_facilities/avaps-dropsonde-system
- **[S4]** NASA Earthdata, “Airborne Vertical Atmospheric Profiling System (AVAPS)”. <https://www.earthdata.nasa.gov/data/instruments/avaps>
- **[S5]** NASA Technical Memorandum 104753, “Issues on Human Acceleration Tolerance” (1993). <https://ntrs.nasa.gov/api/citations/19930020462/downloads/19930020462.pdf>
- **[S6]** NTSB Safety Alert SA-102 (ballistic parachute systems, warning to first responders). <https://www.ntsb.gov/Advocacy/safety-alerts/Pages/SA-102.aspx>
- **[S7]** NASA, “OSIRIS-REx Entry, Descent, and Landing” (SciTech 2025 paper). https://ntrs.nasa.gov/api/citations/20240014280/downloads/OREX_FM_SciTech2025_v2.pdf
- **[S8]** NASA Science, “Mars Pathfinder”. <https://science.nasa.gov/mission/mars-pathfinder/>
- **[S9]** Cadogan, Sandy & Grahne, “Development and evaluation of the Mars Pathfinder inflatable airbag landing system,” Acta Astronautica 50(10), 2002. [https://doi.org/10.1016/S0094-5765\(01\)00215-6](https://doi.org/10.1016/S0094-5765(01)00215-6)
- **[S10]** Kurpiel et al., “Influence of Operation Conditions on Temperature Hazard of Lithium-Iron-Phosphate (LiFePO₄) Cells,” Energies 14(20):6728, 2021. <https://doi.org/10.3390/en14206728>
- **[S11]** U.S. EPA, Method TO-15A (2019), whole-air sampling in canisters. https://www.epa.gov/sites/default/files/2019-12/documents/to-15a_vocs.pdf
- **[S12]** WHO, “Guidance on regulations for the transport of infectious substances” (triple packaging). <https://iris.who.int/server/api/core/bitstreams/ade27b2c-372d-487c-b794-9899318480cb/content>
- **[S13]** IATA Packing Instruction 650 (UN3373), 95 kPa pressure test. <https://www.iata.org/contentassets/b08040a138dc4442a4f066e6fb99fe2a/dgr-65-en-pi650.pdf>

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