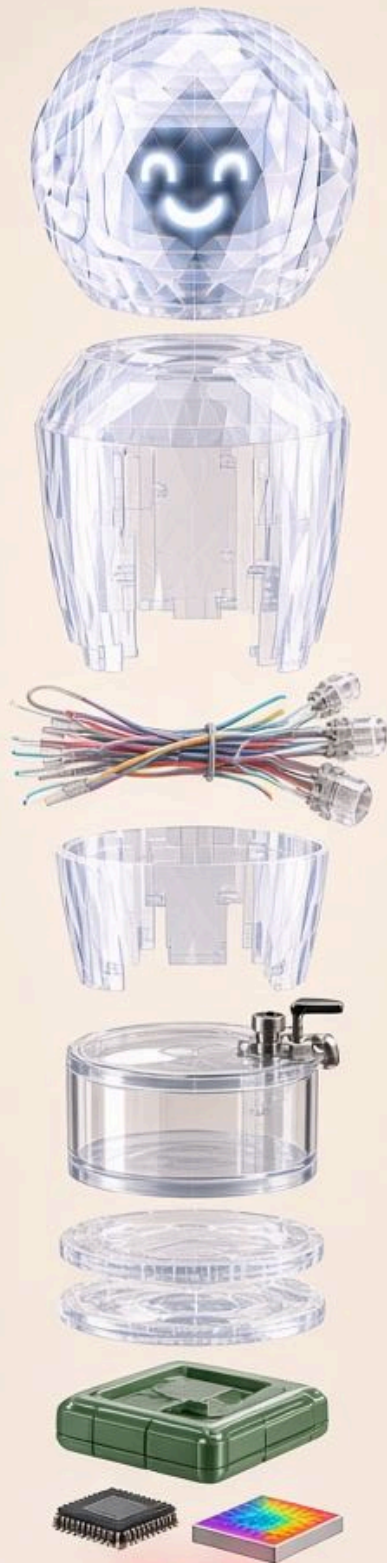
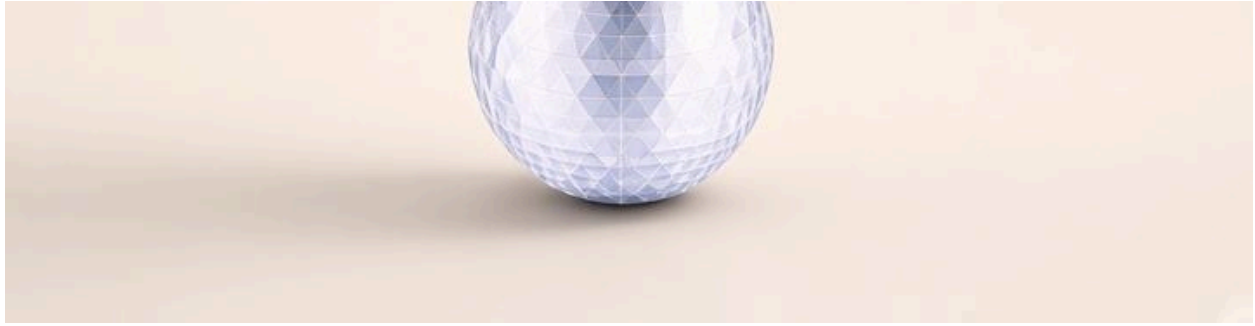


Lumet, the Crystal Guide

Teacher Guide · Grade 3

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





Exploded view of Lumet: top facet with face screen, crystal facets, light-fibre wires, air system, brain and battery, heart and the crystal ball base

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How to use this guide

This guide has the Grade 3 unit. Each unit has 4 or 5 lessons. Students reverse-engineer Lumet, the app's crystal guide: 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 from the lab doors (“Take Lumet apart and see how Lumet works”). Lumet, the app's crystal guide, leads the teardown (Basic mode), the rebuild, naming your version and the material quiz (Advanced mode).
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Lumet at a glance

Lumet is the app's guide: a small, round, gem-cut body of clear crystal facets, like a cut geode, so every part inside is visible. Lumet rolls on one thick-walled hollow crystal ball and can hop over obstacles with a burst of air. A pink heart crystal at the centre shows **status, not feelings**, in candy colours: **green = ready, yellow = working, red = let's fix it**. Lumet is realistic, not cartoonish, and has no self-healing skin. **Honest note:** Lumet is a design concept for the app. Each part is inspired by a real material or living thing; where a published source backs the science, it is cited, and everything else is marked as a design idea. Lumet comes apart in 7 layers, outside to inside:

1. Shell (twist-off top facet, snap-tab crystal facets)
2. Panels and gaskets (jelly gaskets)
3. Face and ear (face screen, ear opening, e-skin touch pads)
4. Light wiring (light-fibre wires, quartz squeeze sensors)
5. Air system (breathing vents, air tank, flytrap snap valve)
6. Power and brain (stomp generator, bacteria battery, brain)
7. Core (heart, hollow crystal ball)



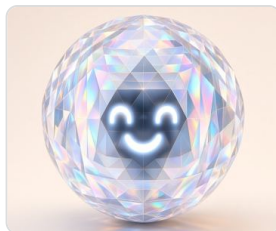
1. Twist-off top facet



2. Snap-tab crystal facets



3. Jelly gaskets



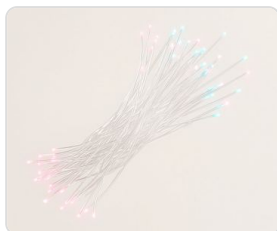
4. Squid-skin pixel face screen



5. Ear opening



6. E-skin touch pads



7. Light-fibre wires



8. Quartz squeeze sensors



9. Breathing vents



10. Air tank



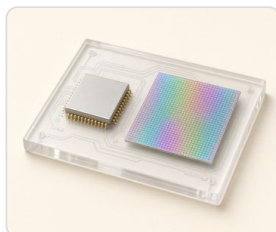
11. Flytrap snap valve



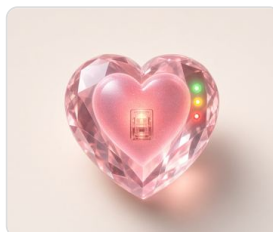
12. Stomp generator



13. Bacteria battery (backup)



14. Brain: chip + photonic-crystal tile



15. Heart



16. Hollow crystal ball

Grade-band progression

Band	Focus
K-2	Shapes and facets, light and colour signals, materials that shed water and seal, taking apart and rebuilding
3-5	Magnets and twist-locks, energy conversion, nature-inspired design
6-8	Light in fibres and structural colour, stored air and fast snaps, signals and codes
9-12	Piezoelectric harvesting, fluorescence and gels, living batteries and bio-inspired cooling, full design review

Grade 3: Twist, Click, Snap: Magnets and Fasteners

4 lessons · about 170 minutes in total · © 2026 Hearts Invention Lab

Overview

Third graders study how Lumet opens and closes without screws: the top facet twists off with a quarter turn and a small magnet helps it click back, and the other facets join with snap tabs (design ideas). Students investigate magnet forces at different distances and design a no-screw lid.

Learning objectives

Students will:

- Investigate how distance changes magnetic force.
- Define a simple design problem solved with magnets.
- Build and test a snap or twist closure.
- Explain why Lumet has no loose screws.

Standards alignment

Framework	Code	What students do (paraphrased)	Status
NGSS	3-PS2-3	Ask questions to find cause-and-effect relationships of magnetic interactions between objects not in contact (paraphrased).	Aligned
NGSS	3-PS2-4	Define a simple design problem that can be solved with magnets (paraphrased).	Aligned
NGSS	3-5-ETS1-1	Define a design problem with criteria and constraints (paraphrased).	Aligned
CCSS	3.MD.B.4	Measure lengths to the half and quarter inch.	Aligned
CCSS	3.G.A.1	Understand shapes in categories.	Suggested alignment
CCSS	W.3.2	Write informative texts.	Aligned

“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 shell (40 min)

1. Take apart the Shell layer; read both cards.

Lesson 2: Magnet distance (hands-on) (45 min)

1. See hands-on.

Lesson 3: No-screw lid (45 min)

1. Design a lid for a cup that twists or snaps on with a magnet assist.
2. Test 10 open-close cycles.

Lesson 4: Explain (40 min)

1. Write: how Lumet opens and why no screws.
2. Rebuild Lumet and name your version.

Materials (household and classroom items only)

- Fridge magnets, paper clips, a ruler
- Paper cups, card, tape, scissors
- Small magnets (adult-supervised; keep away from small children)

Nothing in this unit needs a purchased kit.

Hands-on activity: How Close Is Close Enough?

1. Place a paper clip on the ruler at 0 cm. Slide a magnet toward it.
2. Record the distance when the clip jumps.
3. Repeat 3 times; try a stronger and weaker magnet.
4. Tape a magnet in a cup lid and a clip in the rim; does it help the lid click into place?
5. Link it: Lumet's top facet uses a quarter-turn lock and a small magnet to reseal (design idea, no source).

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 the Reverse Engineer door: "Take Lumet apart and see how Lumet works."
2. Explode Lumet; read every part card.
3. Basic mode: take Lumet apart by layer and rebuild; name your version.
4. Advanced mode: match each of Lumet's parts 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
Twist-off top facet (Clear crystal, bayonet quarter-turn, magnet assist)	Clear crystal keeps every part visible. (design idea, no source)	The access lid.	Bayonet quarter-turn; a magnet helps it reseal. (design idea, no source)
Snap-tab crystal facets (Clear crystal with snap tabs)	Clear crystal cut like a geode. (design idea, no source)	Lumet's body, so you can see inside.	Facets join with snap tabs; no loose screws. (design idea, no source)
Jelly gaskets (Hydrogels)	Hydrogels are soft, wet gels that squish to fill gaps. (design idea, no source)	Seal out dust and water.	Under the panels. (design idea, no source)
Squid-skin pixel face screen (Colour-changing pixels inspired by cephalopod skin)	Cephalopods change colour with skin cells; the pixels copy the idea. (design idea, no source)	Eyes and simple expressions; tap, read, draw.	On the front facet. (design idea, no source)

Part (material)	Why this material was chosen	What the part does	How it is assembled in real life
Ear opening (Water-shedding surface inspired by the lotus leaf)	A lotus leaf's rough, waxy surface makes water bead and roll off. [S2]	Mic and speaker in one opening.	On one side, with a water-shedding surface. (design idea, no source)
E-skin touch pads (Thin, bendy electronic skin)	E-skin is thin and bendy. (design idea, no source)	Detect taps.	Thin pads on the outside facets. (design idea, no source)
Light-fibre wires (Glassy silica filaments)	Sponge glass spicules guide light like fibres. [S5]	Carry signals as light, not electricity.	Filaments run between parts. (design idea, no source)
Quartz squeeze sensors (Quartz (piezoelectric))	Quartz is piezoelectric. [S1]	Sense squeezes and pressure.	Small sensors under the facets. [S1]
Breathing vents (Vent channels inspired by termite mounds)	Termite-mound-style tunnels move air. (design idea, no source)	Cooling and air cushion.	Channels in the lower body. (design idea, no source)
Air tank (Compressed air)	Compressed air stores energy. (design idea, no source)	Burst of air for a hop.	Small tank in the air system. (design idea, no source)
Flytrap snap valve (Fast-snapping valve inspired by the Venus flytrap)	A flytrap leaf snaps in a fraction of a second. [S3]	Fires the hop.	Between tank and jets. (design idea, no source)
Stomp generator (Piezo and triboelectric layers)	Piezo and friction layers make power when squeezed. (design idea, no source)	Recharge while rolling and hopping.	Layers near the ball. (design idea, no source)
Bacteria battery (backup) (Microbial fuel cell)	Bacteria can make a small current in a fuel cell. [S4]	Backup power.	Sealed backup cell. (design idea, no source)
Brain: chip + photonic-crystal tile (Silicon chip + photonic-crystal tile)	Structural colour comes from tiny shapes, not paint. (design idea, no source)	Thinking and colour processing.	Chip plus tile near the centre. (design idea, no source)
Heart (LED, glow film, shimmer coat)	GFP glows green under blue light. [S6]	Status light: green ready, yellow working, red let's fix it. Not feelings.	LED, glow film, shimmer coat. (design idea, no source)
Hollow crystal ball (Thick-walled hollow crystal with honeycomb lining and nacre layers)	Thick hollow crystal with honeycomb and nacre layers is strong for its weight. (design idea, no source)	Rolling base with an air cushion.	One ball underneath; jets around it. (design idea, no source)

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

Lumet is a design for the app, not a machine that has been built. The order below is the app's rebuild order, from the core back out to the shell. (design idea)

1. Place the hollow crystal ball and set the heart at the centre. *[design idea, no source]*
2. Add the brain, bacteria battery and stomp generator. *[design idea, no source]*
3. Fit the air system: vents, air tank and flytrap snap valve. *[design idea, no source]*
4. Run the light-fibre wires and fit the quartz squeeze sensors. *[design idea, no source]*
5. Fit the face screen, ear opening and e-skin pads. *[design idea, no source]*
6. Press in the jelly gaskets. *[design idea, no source]*
7. Snap on the crystal facets, then twist on the top facet. *[design idea, no source]*

This rebuild order is the reverse of the app's teardown (shell, panels and gaskets, face and ear, light wiring, air system, power and brain, core), from the Lumet design spec. It is a design order, not a factory process.

Vocabulary

Word	Meaning
Magnet	An object that pulls on iron or steel.
Attract	Pull toward.
Bayonet lock	A push-and-twist fastener.
Snap tab	A springy hook that clicks into a slot.
Fastener	Something that holds parts together.

Teacher's background (cited facts)

F8 is design; magnet behaviour is investigated by students.

- Design idea (no source): the top facet twists off with a bayonet quarter-turn and a small magnet helps it click back; the other facets join with snap tabs, so there are no loose screws.
- A quartz crystal strains (expands or contracts) when a voltage is applied, and the strain reverses when the voltage reverses: the piezoelectric effect. The crystal's cut and size set how fast it vibrates. [S1]

Discussion questions

1. How did distance change the pull?
2. Why use a magnet only to help, not to hold the whole lid?
3. Why no loose screws in a kids' guide bot?
4. What fastener would you invent?

Assessment

1. What happened as the magnet got closer?
2. How does Lumet's top facet open?
3. How do Lumet's other facets join?
4. One reason for no loose screws?

Answer key

1. The pull got stronger.
2. A quarter twist; a magnet helps it click back.
3. Snap tabs.
4. Nothing small to lose; easy to open and close (design reasoning).

Rubric

Criterion	Not yet	Getting there	Got it!
Magnet test	Unfair	Mostly	Fair and repeated
Design	Doesn't work	Sometimes	Works 10 times
Explanation	Unclear	Some	Clear with reasons

Differentiation and extension

- **Support:** Pre-cut lid templates.
- **Challenge:** Graph distance vs number of clips lifted.
- **Extension:** Find 3 fasteners at home (zip, button, twist cap) and compare.

Safety note

Small magnets are dangerous if swallowed; adults supervise and count them. Keep magnets away from phones and cards.

Sources

Lumet's parts and teardown come from the Hearts Invention Lab app and Lumet design spec. The real-science facts below come from these sources, each checked on 2026-10-20 by matching the DOI's title or reading the page:

- **[S1]** NIST, "Time and Frequency from A to Z: Quartz Oscillator" (page text checked). <https://www.nist.gov/pml/time-and-frequency-division/popular-links/time-frequency-z/time-and-frequency-z-q-ra>
- **[S2]** Barthlott & Neinhuis, "Purity of the sacred lotus, or escape from contamination in biological surfaces," *Planta*, 1997 (DOI title matched). <https://doi.org/10.1007/s004250050096>
- **[S3]** Forterre et al., "How the Venus flytrap snaps," *Nature*, 2005 (DOI title matched). <https://doi.org/10.1038/nature03185>
- **[S4]** Logan et al., "Microbial Fuel Cells: Methodology and Technology," *Environmental Science & Technology*, 2006 (DOI title matched). <https://doi.org/10.1021/es0605016>
- **[S5]** Aizenberg et al., "Biological glass fibers: Correlation between optical and structural properties," *PNAS*, 2004 (DOI title matched). <https://doi.org/10.1073/pnas.0307843101>
- **[S6]** The Nobel Prize in Chemistry 2008, for the discovery and development of the green fluorescent protein, GFP (page checked). <https://www.nobelprize.org/prizes/chemistry/2008/summary/>

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