Cicada Shell

Life Science | Engineering Design Process

Engineering Challenge

Visible Elements in Photo

- A tan/brown insect exoskeleton (shed cicada shell) clinging to tree bark
- Lichen (pale green, crusty patches) covering the bark surface
- Tree bark with varied texture and color (gray, brown, white patches)
- The shell's segmented, ridged structure with distinct head and body sections
- Organic debris and crevices in the bark that provide grip points

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Reasonable Inferences

1. From the shell's clinging position !’ The exoskeleton adheres to the bark without glue or fasteners; it must have a design that grips or locks onto rough, irregular surfaces.
2. From the lichen and bark texture !’ Natural outdoor surfaces are uneven and variable; a structure that works on one spot must adapt to different textures.
3. From the shell's segmented structure !’ The overlapping rings and flexible joints allow the insect to grip and hold weight on a vertical or angled surface despite gravity.

Engineering Task

K-2 Challenge:

"Build a Bug Holder"

Your job: Make a hollow shape (like a cup or shell) that can stick to a bumpy stick or tree branch without falling off. You can use paper, tape, and natural materials. Your holder must:
- Stay on the stick even when you gently tilt it
- Not use glue or tape on the stick itself (only on your holder)
- Have bumps, ridges, or grippers on the inside to hold tight

Why? Just like a cicada sheds its shell and leaves it clinging to bark, your holder needs a good grip!

3-5 Challenge:

"Design a No-Glue Clamp for Tree Bark"

Engineers need structures that grip irregular surfaces without damaging them. Your challenge: Design and build a hollow shell or clamp (inspired by the cicada exoskeleton) that:

- Grips a cylindrical or angular bark-textured surface (tree branch, PVC pipe wrapped in burlap, or actual bark sample)
- Holds a 500g mass (water bottle, sand bag) suspended below for at least 30 seconds
- Uses only interlocking tabs, ridges, friction, or leverage—no adhesives or fasteners through the surface
- Measures no more than 10 cm in length along the grip zone
- Survives at least 3 release-and-reattach cycles without breaking

Success criteria: Your clamp stays secure, the mass doesn't slip, and the grip point shows no cracks or permanent damage.

EDP Phase Targeted

Ask / Define Problem

This photo works best as an entry to the EDP because students must first observe and wonder: "How does this shell stay stuck without glue?" Nature provides the real-world problem (adhering to irregular surfaces), and students must then ask what features of the shell make gripping possible. This inquisitive phase builds motivation before they imagine solutions.

Suggested Materials

- Paper cups, paper towel tubes, or rolled poster board (base structure)
- Tape (duct, masking, or painter's tape) (flexible fastening)
- Craft foam sheets or foam pipe insulation (moldable gripping ridges)
- Rough textured materials: burlap, sandpaper, or corrugated cardboard (friction surface)
- Tree branches, PVC pipes, or dowels (test surfaces to grip)
- Optional: rubber bands, clothespins, or clothesline (mechanical advantage)

Estimated Time

- K–2: 45–60 minutes (includes observation, design sketch, building, and one round of testing)
- 3–5: Two 45-minute sessions (Day 1: observe, sketch design, material prep; Day 2: build, test, troubleshoot, redesign)

Why This Works for Teachers

This challenge directly addresses NGSS 3-5-ETS1-1 (Ask questions to define problems) and K-2-ETS1-1 (ask questions, make observations, and gather information) by anchoring the design task in a visible natural structure, making the "why we build" question concrete and observable rather than abstract.