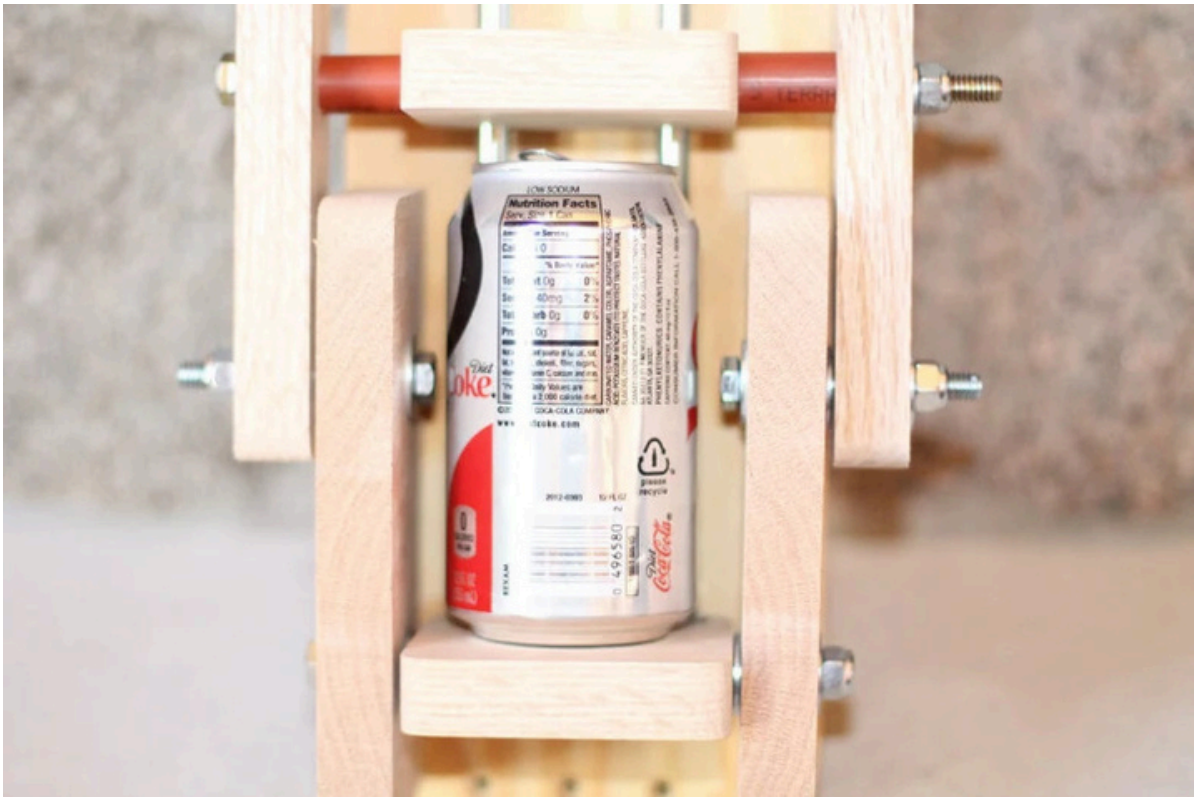
Crusher Stress Test



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Crusher Stress Test

The Crusher Stress Test STEAM Kit allows students to design and test small structures under increasing weight or pressure using a custom crusher frame, 2-liter bottle, funnel, and a PVC pipe placeholder. Students construct towers or platforms using classroom-safe materials (e.g., paper, cardboard, straws), place them beneath the crusher frame, and gradually fill the bottle with water or sand to simulate increasing stress. The kit provides a powerful, visual way to explore engineering design, compression forces, and material failure—all while encouraging experimentation and iteration.

Grade Level

4th - 10th

Group Size

2 - 4 students per group

Time Duration

45 - 90 minutes per cycle

Content of Kits

Components

- Crusher frame
- 1 2-liter bottle
- funnel
- PVC pipe placeholder

Concumables

- Sand (not included)
- Materials for creating crushable structures like balsa wood, popsicle sticks, etc. (not included)

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Usage

Getting Started

1. **Explain Compression and Structural Stress -** Begin with a quick demonstration or diagram showing how force travels through a structure and causes materials to deform or fail.

2. **Show the Crusher Frame Setup -** Assemble the crusher frame and insert the 2-liter bottle, funnel, and PVC placeholder to demonstrate how pressure will be applied.

3. **Set Safety Boundaries -** Establish a clear testing area and remind students to observe without placing hands under the crusher during testing.

4. **Review Design Materials -** Provide or allow selection of safe building materials (paper, straws, cardboard, index cards, etc.) and show examples of potential structural designs.

5. **Explain Testing Procedure -** Describe how teams will load water or sand into the funnel slowly, observe the structure under pressure, and measure how much mass the structure holds before failing.

Storage

- **Keep Bottle Empty During Storage -** Always empty the 2-liter bottle after use and store it dry to prevent mold or mildew.

Troubleshooting

- **Bottle Not Applying Even Pressure -** Ensure the bottle is centered and the funnel is filling gradually to keep force distributed directly onto the test material.
- **Structure Doesn't Collapse Even Under Full Load -** Consider using denser fill material or reducing the structure's base support to increase test sensitivity.
- **Leakage or Spillage During Test -** Use a tray or shallow bin under the crusher to catch overflow or leaks. Test fill materials in small batches first.
- **Frame Wobbles or Shifts -** Place the crusher on a flat surface and stabilize the base with weights or clamps if needed.

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Activity Guide

Beginner

Paper Column Challenge
Students roll sheets of paper into tubes and arrange them vertically to form support columns. They place the columns under the crusher and slowly fill the bottle with water. After recording when the columns collapse, they compare different shapes (square, round, triangular) to see which holds the most weight.

Intermediate

Material Comparison Test
Students design identical tower structures using various classroom-safe materials (e.g., paper, cardboard, straws, craft sticks) and test each under the crusher. They record data on how much weight each structure supports and graph the results to draw conclusions about material strength.

Advanced

Design for Maximum Load
Teams research structural design techniques (like trusses, arches, or honeycomb cores), then build and test their own model with a goal of holding the maximum possible load. After initial testing, students refine their designs and re-test to improve efficiency and load distribution.

Extension Activities:

Real-World Structure Failure Analysis
After testing, students research real structural collapses (e.g., bridges, towers, buildings) and identify how compression or load failure played a role. They present a short report or infographic comparing their classroom results to actual case studies, focusing on what engineers have learned from failure.

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Learning Extensions

STEAM Connections: Engineering - Math - Science

Learning Objectives:

- Understand how compression and structural stress affect the integrity of materials and designs.
- Apply the engineering design process through prototyping, testing, and redesign.
- Collect, analyze, and interpret data to evaluate performance under increasing force.
- Compare the effectiveness of different structural shapes and materials.
- Reflect on design failures and use observations to inform improvements.

Career Connections:

- **Civil Engineer –** Designs buildings, bridges, and infrastructure that must withstand pressure and environmental stress.
- **Structural Engineer –** Evaluates how load and stress affect materials in construction and architecture.
- **Architect –** Considers both form and function when designing stable and sustainable structures.
- **Materials Scientist –** Tests how different materials perform under stress for use in manufacturing, aerospace, and construction.
- **Safety Inspector –** Assesses structural safety and ensures that systems meet engineering and building standards.

Essential Employability Skills:

- Problem-Solving
- Critical Thinking
- Teamwork
- Attention to Detail
- Communication

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Resources and Accessibility

Safety Guidelines

- **Keep Hands Clear During Testing -** Never place hands or fingers under the crusher frame once the load is being applied.
- **Use Only Approved Materials -** Limit test structures to soft, safe materials (e.g., paper, cardboard) that won't splinter or create sharp debris.
- **Use a Spill Tray -** Place a shallow bin or towel under the crusher to catch any overflow from the bottle or funnel.
- **Clean Up After Use -** Empty the bottle and dry all parts thoroughly to prevent mold or material degradation between uses.

Accessibility

- **Pre-Cut or Pre-Rolled Materials -** Offer pre-cut paper or partially rolled columns to reduce fine motor demands for students who need support.
- **Flexible Role Assignments -** Allow students to participate as recorders, designers, or observers if direct interaction with the apparatus is challenging.
- **Provide Visual Data Tools -** Use visual supports like illustrated testing charts or large-print data logs for students with visual processing needs.
- **Adjust Testing Table Height -** Ensure the testing area is at a height accessible to all students, including those using wheelchairs.
- **Incorporate Verbal Observations -** Allow students to dictate or describe observations aloud if writing or logging data is difficult.

Library Catalog

Library Resources

Feedback

QR to feedback survey