★ PREMIUM RESOURCE ★

STEM Challenge Card Deck

40 Low-Cost Engineering Challenges Using Everyday & Teacher-Provided Materials

Grades 3 – 8 | Print & Google Slides

- 40 Challenge Cards (Print-ready & Digital)
- Materials Reference List
- Engineering Design Process Poster
- Student Reflection Journal
- Teacher Tips & Facilitation Guide

Imagine • Plan • Create • Test • Improve

UM Printables — Premium Educational Resources

M Materials Reference List

Low-Cost Supplies for All 40 Challenges

One of the best features of this STEM Challenge Card Deck is that it relies entirely on low-cost, everyday classroom materials. Below is a core list of the supplies used most often across the 40 challenges; individual challenges may also require teacher-provided testing items. Most items can be found in a standard classroom, recycled from home, or purchased at a dollar store. Quantities are suggested for a class of 30 students working in groups of 3–4 over the course of the 40 challenges.

Material	Suggested Quantity	Notes / Low-Cost Sources
Masking Tape	4–6 rolls	Essential for almost every challenge. Buy in bulk.
Index Cards	2–3 packs (100 ct)	Used for structures, hinges, and brainstorming notes.
Plastic Straws	1 box (200+)	Standard straight straws. Flexible straws work too.
Popsicle Sticks	1 box (500+)	Standard or jumbo. Great for structures and levers.
String / Yarn	1 roll (100+ ft)	Any thickness. Used for pulleys, ties, and pendulums.
Rubber Bands	1 assorted bag	Various sizes needed for tension, launchers, and wheels.
Paper Clips	1 box (100 ct)	Standard size. Used as connectors and hooks.
Aluminum Foil	1 roll (25 ft)	Used for boats, heat reflectors, and conductive elements.
Cardboard	Recycled	Cereal boxes, delivery boxes, toilet paper tubes. Free!
Pipe Cleaners	1 pack (100 ct)	Excellent for flexible connections and joints.
Plastic Cups	50–100 cups	Standard 8–12 oz solo cups. Great for towers and pulleys.
Toothpicks	1 box (500+)	Used with marshmallows or clay for mini-structures.
Play-Doh / Clay	3—4 tubs	Used as weights, anchors, and joint connectors.
Copy Paper	Recycled / Standard	Used for paper airplanes, folding, and sketching.
Scissors	1 per student	Standard classroom supply.
Rulers	1 per group	For measuring during the "Plan" and "Test" stages; a protractor may also be used for Challenge 10.

E Engineering Design Process Poster

Classroom Visual Reference

Print this page in color and display it in your classroom or STEM lab. It serves as a visual anchor for students as they work through their challenges. Every challenge card in this deck uses this classroom six-step process.

■ Step 1: ASK

What is the problem? Who needs it? What are the rules and constraints (materials, time, size)? Understand the challenge before you begin.

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■ Step 2: IMAGINE

Brainstorm as many solutions as possible. No idea is too wild! Think outside the box and talk with your team about different approaches.

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■ Step 3: PLAN

Choose the best idea from your brainstorm. Sketch a detailed diagram of your design. Label the materials you will use and assign team roles.

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■ Step 4: CREATE

Build your prototype! Follow your plan, but be flexible if you need to make small adjustments as you build. Work together as a team.

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■ Step 5: TEST

Put your design to the test! Does it solve the problem? Does it meet all the constraints? Record your results and observe what happens.

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■ Step 6: IMPROVE

How can you make it better? If it failed, why? If it worked, can it be stronger, faster, or use fewer materials? Go back and redesign! Remember: the EDP is a cycle, so unexpected results can lead you back to Ask or Plan.

F Teacher Facilitation Playbook

Turn each challenge into a deeper engineering-learning experience

Before Students Build

- **Frame the problem:** Read the brief, identify who or what the design is for, and have students restate the goal in their own words.
- **Name the criteria:** Ask, “What must the design do to count as successful?” Make measurable criteria visible.
- **Name the constraints:** Materials, time, dimensions, testing conditions, and safety rules should be explicit before materials are distributed.
- **Predict before building:** Ask students what they expect to happen and why. A prediction gives the first test something to compare with.

While Students Build

- **Ask, do not rescue:** Use questions such as “What is causing that problem?” and “What could you change while keeping the same constraint?”
- **Protect productive struggle:** Give hints that preserve ownership of the design rather than supplying the solution.
- **Listen for evidence:** Ask students to describe what they observed, not only what they think should have happened.
- **Require iteration:** Encourage at least one intentional redesign when time and safety allow.

After Testing

- **Compare evidence:** What changed from Trial 1 to Trial 2? Which result best met the criteria?
- **Explain the mechanism:** Ask students to connect the result to a science idea such as force, stability, energy transfer, friction, or structure.
- **Make the redesign specific:** Replace “make it better” with “What one change will you make, and what result do you predict?”
- **Communicate:** Have students give a short evidence-based explanation of their design choice and improvement.

? Teacher Question Bank

What is the strongest evidence that your design worked? Which constraint was hardest to satisfy? What changed between trials? What variable did you control? What would you test next? Which part of another team’s design would you borrow, and why?

Safety & Testing Guide

A consistent classroom routine for hands-on engineering

Activity Type	Teacher Setup	Student Expectation
Projectiles / launchers	Create a clear testing lane; use lightweight projectiles only.	Launch only toward the designated area; never toward people.
Drop tests	Choose a clear landing zone and control height where appropriate.	Stand outside the drop zone and wait for the teacher signal.
Sharp materials	Provide teacher supervision and collect loose pins/toothpicks after use.	Carry and place sharp items carefully; no pointing or horseplay.
Fans / airflow	Secure fan placement and keep cords/airflow paths clear.	Keep hands, hair, and loose materials away from moving parts.
Water challenges	Use a stable container on a protected surface and plan spill cleanup.	Move slowly around wet areas and wipe spills immediately.
Mouth-contact activities	Provide fresh, individual straws or mouthpieces and do not share.	Use only your assigned mouth-contact material.

! Safety Principle

Use the challenge card as the design brief, but adapt the testing procedure to your classroom, equipment, student needs, and school safety procedures. When a test introduces a risk, the teacher controls the setup and the release of the test.

D

Fair Tests & Data Collection

Move students from “It worked!” to evidence-based conclusions

Five Questions for a Fair Test

1. What is the design variable you are changing?

2. What outcome are you measuring or observing?

3. What should stay the same between trials?

4. How many trials will you run?

5. What evidence will you use to decide which design is better?

Trial	Measurement / Result	Observation
1		
2		
3		
Average / Best Result		

? Teacher Prompt

If a student changes two variables at once, ask: “How will you know which change caused the difference?” This simple question moves the conversation toward controlled testing.

Student Reflection Journal

Thinking Like an Engineer

Print multiple copies of this journal page for your students. Completing a reflection after each challenge is crucial for solidifying the engineering concepts and math/science connections. Have students fill this out after the "Test" and "Improve" stages.

Pre-Challenge Plan

Challenge Name:		**Date:**	

Our Goal:

What must our design do to succeed?

Our Plan (Sketch & Material List):

Sketch here...	*Materials needed...*

Post-Challenge Reflection

Did your design meet the goal?	■ Yes ■ Partially ■ No
What worked well?	
What failed or needs improvement?	
If you did this again, what would you change?	

1 STEM Challenge Cards: Set 1

Structures (Challenges 1 – 10)

Print these cards and laminate for repeated use, or distribute digitally via the included Google Slides. Each challenge follows the Engineering Design Process.

CHALLENGE 1

Challenge Brief: Build a bridge that spans a 10-inch gap between two desks using only paper and tape. It must hold the weight of 5 pennies in the center.

Materials Allowed: 5 sheets of copy paper, 1 foot of masking tape, 5 pennies (for testing).	**Constraints:** The bridge cannot be taped to the desks. You cannot use the tape as structural support (like a suspension cable), only as a connector.

Follow the Engineering Design Process:
1. **Ask:** What is the problem?
2. **Imagine:** Brainstorm 2 solutions.
3. **Plan:** Sketch your best idea.
4. **Create:** Build your prototype.
5. **Test:** Does it meet the goal?
6. **Improve:** How can you make it better?

Reflection Prompt: How did folding or rolling the paper change its strength? What shape held the most weight?

CHALLENGE 2

Challenge Brief: Construct the tallest freestanding tower possible using index cards and a limited amount of masking tape. It must stand on its own for at least 10 seconds.

Materials Allowed: 20 index cards, 1 foot of masking tape.	**Constraints:** The tower cannot lean against a wall or any other object. You may cut or fold the cards, but cannot use more than 1 foot of tape.

Follow the Engineering Design Process:
1. **Ask:** What is the problem?
2. **Imagine:** Brainstorm 2 solutions.
3. **Plan:** Sketch your best idea.
4. **Create:** Build your prototype.
5. **Test:** Does it meet the goal?
6. **Improve:** How can you make it better?

Reflection Prompt: What base shape (triangle, square, circle) made the most stable foundation? Why?

2 STEM Challenge Cards: Set 2

Forces & Motion (Challenges 11 – 20)

These challenges focus on gravity, friction, potential & kinetic energy, and Newton's Laws of Motion. Print and laminate for repeated use!

CHALLENGE 11

Challenge Brief: Design a carrier that can transport a small toy or Play-Doh figure down a 5-foot zip line as safely and slowly as possible without getting stuck.

Materials Allowed: Teacher-provided 5-foot support/zip line, 2 straws, 2 paper clips, 1 index card, 1 foot of masking tape.	**Constraints:** The carrier must travel the full 5 feet. You cannot push the carrier; it must move using gravity and friction alone.

Follow the Engineering Design Process:
1. Ask: What is the problem?
2. Imagine: Brainstorm 2 solutions.
3. Plan: Sketch your best idea.
4. Create: Build your prototype.
5. Test: Does it meet the goal?
6. Improve: How can you make it better?

Reflection Prompt: How did friction affect the speed of your rider? What did you do to slow it down or prevent it from getting stuck?

CHALLENGE 12

Challenge Brief: Build a car that is powered entirely by the air escaping a balloon. It must travel across the floor at least 3 feet.

Materials Allowed: 1 cardboard base (4x6 inches), 4 cardboard circles (wheels), 2 straws, 2 toothpicks/popsicle sticks (axles), 1 balloon, 1 foot of masking tape.	**Constraints:** You cannot push the car. The balloon must be attached to the car, and the escaping air must provide the forward thrust.

Follow the Engineering Design Process:
1. Ask: What is the problem?
2. Imagine: Brainstorm 2 solutions.
3. Plan: Sketch your best idea.
4. Create: Build your prototype.
5. Test: Does it meet the goal?
6. Improve: How can you make it better?

Reflection Prompt: How did the direction of the air escaping the balloon affect the direction the car moved? What is Newton's Third Law of Motion?

3 STEM Challenge Cards: Set 3

Flight & Aerospace (Challenges 21 – 30)

These challenges explore aerodynamics, lift, drag, and air pressure. Perfect for exploring the principles of flight!

CHALLENGE 21

Challenge Brief: Build a glider using a straw and paper hoops that can fly across the room. It must glide smoothly, not just fall.

Materials Allowed: 1 plastic straw, 1 index card, 1 foot of masking tape.	**Constraints:** The glider must be thrown by hand. The hoops must be attached to the straw. You cannot use any other materials for weight.

Follow the Engineering Design Process:
1. **Ask:** What is the problem?
2. **Imagine:** Brainstorm 2 solutions.
3. **Plan:** Sketch your best idea.
4. **Create:** Build your prototype.
5. **Test:** Does it meet the goal?
6. **Improve:** How can you make it better?

Reflection Prompt: How did the size of the hoops affect the way the glider flew? Why does the hoop glider fly even though it doesn't look like a normal airplane?

CHALLENGE 22

Challenge Brief: Design a paper helicopter (whirlybird) that spins slowly and safely to the ground when dropped from about 5 feet in a clear testing area.

Materials Allowed: 1 sheet of copy paper, 1 paper clip, scissors.	**Constraints:** You cannot throw the whirlybird; it must be dropped. The paper clip must be used for weight at the bottom.

Follow the Engineering Design Process:
1. **Ask:** What is the problem?
2. **Imagine:** Brainstorm 2 solutions.
3. **Plan:** Sketch your best idea.
4. **Create:** Build your prototype.
5. **Test:** Does it meet the goal?
6. **Improve:** How can you make it better?

Reflection Prompt: How did air resistance push against the blades to make it spin? What happened when you made the blades longer or shorter?

4 STEM Challenge Cards: Set 4

Nature & Energy (Challenges 31 – 40)

These challenges focus on energy transfer, environmental engineering, and biomimicry. Great for Earth Day or life science connections!

CHALLENGE 31

Challenge Brief: Design a solar oven that uses radiant energy from a lamp or sunlight to melt a small piece of chocolate or crayon.

Materials Allowed: 1 cardboard box, 1 sheet of aluminum foil, 1 plastic cup, 1 foot of tape.	**Constraints:** You cannot use a magnifying glass to focus light directly on the chocolate. The foil should reflect radiant energy toward the heating area.

Follow the Engineering Design Process:
1. Ask: What is the problem?
2. Imagine: Brainstorm 2 solutions.
3. Plan: Sketch your best idea.
4. Create: Build your prototype.
5. Test: Does it meet the goal?
6. Improve: How can you make it better?

Reflection Prompt: How did the foil help direct radiant energy? How did enclosing the cup affect heat transfer, and how is that similar to—but different from—a greenhouse?

CHALLENGE 32

Challenge Brief: Build a tall tower with lightweight blades at the top that can withstand the "wind" from a fan without blowing over or bending.

Materials Allowed: 5 straws, 5 index cards, 1 foot of tape, 1 paper clip.	**Constraints:** The tower must be at least 12 inches tall. The index card "blades" must be attached at the top. It must stand freely without being taped to the desk.

Follow the Engineering Design Process:
1. Ask: What is the problem?
2. Imagine: Brainstorm 2 solutions.
3. Plan: Sketch your best idea.
4. Create: Build your prototype.
5. Test: Does it meet the goal?
6. Improve: How can you make it better?

Reflection Prompt: How did the shape of the blades affect the wind force on the tower? Did a wider base make your tower more stable?

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STEM CHALLENGE CARD DECK

What is included in the full 41-page resource

- 40 ready-to-use engineering challenges
- Grades 3–8 with practical differentiation
- Structures • Forces & Motion
- Flight & Aerospace • Nature & Energy
- Materials, constraints, EDP, testing, and reflection on every card

- Teacher Tips & Facilitation Guide
- Materials Reference + prep checklist
- Teacher Facilitation Playbook
- Team Roles & Classroom Routines
- Safety & Testing Guide

- Fair Tests & Data Collection
- 4-point Engineering Process Rubric
- Grades 3–5 / Grades 6–8 differentiation
- Planning At-a-Glance for all 40 challenges

- Student Reflection Journal
- STEM Vocabulary Bank
- Standards Connections & Extension Moves
- Engineering Design Process classroom poster
- Google Slides digital-use guidance

BUILT AS A COMPLETE STEM SYSTEM

Use the cards for quick builds or extended engineering blocks. Pair the same challenge with planning, fair testing, evidence, reflection, redesign, and grade-band supports.

40 CHALLENGES • 4 STEM DOMAINS • TEACHER + STUDENT TOOLS

TPT PREVIEW • Selected sample pages shown • Full resource contains all listed components