

# MAKERSPACE CHALLENGE CARDS

50 Engineering Challenges

Grades 2 - 8 | Everyday Materials

Color-Coded by Difficulty • Engineering Design Process • Build Journals

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UM Printables

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# Introduction & How to Use This Deck

Welcome to the **Makerspace Challenge Card Deck**, a collection of 50 hands-on engineering challenges designed for students in Grades 2 through 8. These cards use everyday, low-cost materials to spark creativity, foster problem-solving, and bring the Engineering Design Process to life in your classroom or library makerspace.

## Color-Coded Difficulty

Each challenge card is color-coded to help you and your students choose the right level of complexity:

| Color                                                                             | Difficulty   | Description                                                                                              |
|-----------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------|
|  | Beginner     | Straightforward builds, fewer variables, excellent for Grade 2-4 or introduction to makerspaces.         |
|  | Intermediate | Requires more structural integrity, basic physics (balance, friction), suitable for Grades 4-6.          |
|  | Advanced     | Complex constraints, moving parts, kinetic energy, suitable for Grades 6-8 or advanced younger students. |

## How to Use the Cards

- **Card Selection:** Let students draw a card at random, or assign specific cards to match your science curriculum (e.g., select bridge challenges during a forces unit).
- **Material Prep:** Use the Materials Reference Guide to set up a 'Maker Bar'. Most challenges use recyclables and basic classroom supplies.
- **The Build Journal:** Print the appropriate Student Build Journal page to guide students through the Engineering Design Process before, during, and after the build.
- **Time Limits:** Cards suggest a time range. For a 45-minute class, spend 5 mins reading/planning, 30 mins building, 10 mins testing and reflecting.
- **Gallery Walks:** Use the included Display/Gallery Rubric to host a showcase where students present their creations and evaluate peer designs.

# Engineering Design Process Poster

Display this poster in your makerspace to help students understand the cyclical nature of engineering. Every challenge card references these five steps.

## 1. ASK

What is the problem? What are the constraints?

## 2. IMAGINE

Brainstorm solutions. Think of wild ideas!

## 3. PLAN

Choose one idea. Sketch it and list materials.

## 4. CREATE

Build your prototype! Follow your plan but be flexible.

## 5. IMPROVE

Test it. What works? What doesn't? Make it better!

### Remember: It's a Cycle!

- Engineers rarely get it right the first time. If your design fails during the TEST, go back to IMAGINE or PLAN and try again. Failure is just data!

# Materials Reference Guide

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All 50 challenges use everyday, low-cost materials. Set up a 'Maker Bar' with the following items to ensure students have what they need. Materials are categorized by function.

## Structural & Base Materials

- Cardboard sheets and tubes
- Cereal boxes / shoe boxes
- Popsicle sticks / craft sticks
- Paper cups (plastic or paper)
- Plastic bottles and caps
- Newspaper

## Connectors & Fasteners

- Masking tape (lots of it!)
- Duct tape
- Glue sticks / liquid glue
- Rubber bands (various sizes)
- Paper clips / binder clips
- Brass brads / pipe cleaners
- String / yarn

## Weights & Motion

- Pennies or washers (for weight)
- Marbles / ping pong balls
- Balloons
- Straws
- Spaghetti noodles (dry)

## Tools & Measurement

- Scissors
- Rulers
- Hole punchers
- Markers / colored pencils
- Timer / stopwatch

# Challenge Cards: Beginner

These challenges are color-coded **GREEN** for Beginner difficulty. They are straightforward builds with fewer variables, making them excellent for Grades 2-4 or as an introduction to the makerspace.

**Printing Tip:** Print these pages on cardstock or heavy paper, then cut along the dotted lines to create your deck of challenge cards.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| <div><b>BEGINNER: Spaghetti Tower</b></div> <div><b>Challenge:</b> Build the tallest freestanding tower using only dry spaghetti and marshmallows. It must stand on its own for at least 10 seconds!</div> <div><b>Materials:</b> 20 dry spaghetti sticks, 10 mini marshmallows</div> <div>■■ EDP Step: <b>IMAGINE:</b> How will you make a wide base so it doesn't fall over?</div> <div>■ <b>Reflection:</b> What part of your tower was the weakest? How could you make it stronger?</div> | <div><b>BEGINNER: Paper Bridge</b></div> <div><b>Challenge:</b> Construct a bridge that spans a 6-inch gap between two books. The bridge must hold 10 pennies without collapsing!</div> <div><b>Materials:</b> 2 sheets of copy paper, 10 inches of masking tape, 10 pennies</div> <div>■■ EDP Step: <b>PLAN:</b> Draw a sketch of your bridge before you start building.</div> <div>■ <b>Reflection:</b> Did folding or rolling the paper make it stronger? Why?</div> |
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### BEGINNER: Cup Pyramid

**Challenge:** Stack 20 paper cups into the tallest possible freestanding pyramid or tower. You cannot use any tape or glue!

**Materials:** 20 paper or plastic cups

■ ■ EDP Step: ASK: What shapes are the most stable when stacking?

■ **Reflection:** How did you arrange the cups at the bottom to support the top?

### BEGINNER: Aluminum Boat

**Challenge:** Design a boat out of aluminum foil that floats in a bowl of water. It must be able to hold at least 15 pennies without sinking!

**Materials:** 1 sheet of aluminum foil (12x12 inches), 15 pennies, Bowl of water

■ ■ EDP Step: CREATE: Build your boat, making sure there are no holes for water to leak in.

■ **Reflection:** Where did the water come in first when it sank? How would you change the shape?

### BEGINNER: Pompom Launcher

**Challenge:** Create a device that launches a pompom as far across the room as possible using the power of air!

**Materials:** 1 paper cup, 1 balloon, 1 pompom, Tape

■ ■ EDP Step: **IMAGINE:** What happens to the air when you stretch and release the balloon?

■ **Reflection:** How did the size of the balloon pull affect the distance the pompom traveled?

### BEGINNER: Newspaper Tower

**Challenge:** Build a tower that is taller than 2 feet using only newspaper and a small amount of tape. It must stand without anyone holding it!

**Materials:** 3 sheets of newspaper, 12 inches of masking tape, Ruler

■ ■ EDP Step: **PLAN:** Will rolling the paper into tubes make it taller or stronger?

■ **Reflection:** Did you run out of tape? How did you hold the paper together without tape?

### BEGINNER: Plastic Bag Parachute

**Challenge:** Design a parachute that slows down a small toy figure's fall. Drop it from a high point and watch it float!

**Materials:** 1 plastic grocery bag, 4 pieces of string (12 inches each), 1 small toy, Tape

■ ■ EDP Step: **CREATE:** Make sure the strings are evenly spaced around the plastic.

■ **Reflection:** Did the parachute drop fast or slow? What happens if you make the plastic bag bigger?

### BEGINNER: String Zip Line

**Challenge:** Build a carrier that can slide down a piece of string from a high point to a low point without falling out.

**Materials:** 1 piece of string (3 feet), 1 small paper cup, 1 straw, Tape

■ ■ EDP Step: **ASK:** How will you attach the cup to the string so it slides easily?

■ **Reflection:** How did the angle of the string change the speed of the carrier?

### BEGINNER: Straw Bridge

**Challenge:** Build a bridge using straws and tape that spans a 4-inch gap. It must be strong enough to hold a small book!

**Materials:** 10 drinking straws, 12 inches of masking tape, 1 small light book

■■ EDP Step: IMAGINE: How can you make a straw stronger? (Hint: triangles!)

■ **Reflection:** Did the straws bend or crush? Where did you need the most tape?

### BEGINNER: Paper Airplane Distance

**Challenge:** Fold a paper airplane that flies straight and far. It must fly at least 10 feet across the room!

**Materials:** 2 sheets of copy paper, 1 paper clip, Measuring tape

■■ EDP Step: PLAN: Will you fold sharp points or blunt edges? Sketch your design.

■ **Reflection:** What did the paper clip do to the front of the plane? Did it fly better?

### BEGINNER: Ping Pong Drop

**Challenge:** Create a safe container that protects a ping pong ball when dropped from shoulder height. The ball cannot bounce out!

**Materials:** 5 straws, 1 foot of tape, 1 paper towel, 1 ping pong ball

■■ EDP Step: CREATE: Build a nest or a box to cushion the ball.

■ **Reflection:** Did the ball bounce out? How could you make the opening smaller?

### BEGINNER: Ring Toss Game

**Challenge:** Design a ring toss game. Build 3 rings out of paper plates and 1 standing target out of a cardboard tube.

**Materials:** 3 paper plates, 1 paper towel tube, 1 piece of cardboard (6x6), Tape

■■ EDP Step: ASK: How heavy should the rings be so they don't blow away but can hook the target?

■ **Reflection:** Was it hard to throw the rings? How could you make the target sturdier?

### BEGINNER: Balloon Rocket

**Challenge:** Build a rocket that travels along a string from one side of the room to the other using air power!

**Materials:** 1 balloon, 1 long piece of string (6+ feet), 1 straw, Tape

■ ■ EDP Step: IMAGINE: Which direction will the rocket move when the air rushes out?

■ **Reflection:** What happened if the string wasn't tight? How fast did it go?

### BEGINNER: Pipe Cleaner Tower

**Challenge:** Build the tallest freestanding tower using only pipe cleaners. You cannot use any tape or glue!

**Materials:** 15 pipe cleaners

■ ■ EDP Step: PLAN: How will you twist the ends together to make them stick?

■ **Reflection:** Was it hard to get it to stand up straight? What shape helped the most?

### BEGINNER: Cardboard Ramp

**Challenge:** Build a ramp using cardboard and books. The goal is to make a marble roll down the ramp and travel the farthest distance on the floor!

**Materials:** 1 piece of cardboard, 3-4 books, 1 marble, Tape (optional)

■ ■ EDP Step: CREATE: Prop the cardboard up on the books to make a slope.

■ **Reflection:** Did a steeper ramp make the marble go further, or did it crash? Why?

### BEGINNER: Cork Boat

**Challenge:** Build a small boat using corks and rubber bands that floats and can carry 5 pennies without sinking!

**Materials:** 3-4 wine corks, 3 rubber bands, 5 pennies, Bowl of water, 1 toothpick & paper (for sail)

■ ■ EDP Step: ASK: Why do corks float? How can you connect them together?

■ **Reflection:** Did the boat tip over when you added the pennies? Where did you put them?

### BEGINNER: Sticky Note Structure

**Challenge:** Build a 3D structure using only sticky notes. No tape or glue allowed! The sticky part of the note is the only thing holding it together.

**Materials:** 15-20 sticky notes

■ ■ EDP Step: IMAGINE: Can you fold the notes to make them stronger or stand up taller?

■ **Reflection:** Was the sticky part strong enough? How high could you build before it fell?

# Challenge Cards: Intermediate

These challenges are color-coded **ORANGE** for Intermediate difficulty. They require more structural integrity, basic physics (like balance, friction, and tension), and are suitable for Grades 4-6 or advanced younger students.

## INTERMEDIATE: Rubber Band Car

**Challenge:** Build a car that moves using the tension of rubber bands. The car must travel at least 3 feet forward without being pushed!

**Materials:** Cardboard body (4x6 inches), 2 wooden skewers, 4 plastic bottle caps, 2 rubber bands, Tape

■■ EDP Step: **PLAN:** How will you wrap the rubber band around the axle so it unwinds and spins the wheels?

■ **Reflection:** Did your wheels spin freely? How did the number of times you wound the rubber band affect the distance?

## INTERMEDIATE: Straw Roller Coaster

**Challenge:** Design a roller coaster track for a marble using straws. The marble must travel from start to finish without falling off, and include at least one loop or hill!

**Materials:** 20 drinking straws, 1 cardboard base (8x10 inches), Masking tape, 1 marble

■■ EDP Step: **IMAGINE:** How will you support the loop so it doesn't collapse under the marble's weight?

■ **Reflection:** Where did the marble fall off? How did you have to adjust the angle of the hill?

# Challenge Cards: Advanced

These challenges are color-coded **RED** for Advanced difficulty. They involve complex constraints, moving parts, kinetic energy, and multi-step mechanisms. They are suitable for Grades 6-8 or advanced younger students.

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| <div><b>ADVANCED: Da Vinci Bridge</b></div> <div><b>Challenge:</b> Build a self-supporting bridge using only popsicle sticks. No glue, no tape, no fasteners! It must hold together using only friction and gravity, and span a 10-inch gap.</div> <div><b>Materials:</b> 30-40 popsicle sticks</div> <div>■■ EDP Step: <b>IMAGINE:</b> How can the sticks weave together so that the weight of the bridge actually makes it tighter and stronger?</div> <div>■ <b>Reflection:</b> Where did the bridge want to collapse? How does adding weight in the middle change how the sticks push against each other?</div> | <div><b>ADVANCED: Mousetrap Car</b></div> <div><b>Challenge:</b> Build a vehicle powered by the snap of a standard mousetrap. It must travel at least 5 feet forward!</div> <div><b>Materials:</b> 1 standard mousetrap, 2 wooden skewers (for axles), 4 CD/Cardboard wheels, String, Tape, 2 small eye hooks (optional)</div> <div>■■ EDP Step: <b>PLAN:</b> How will you attach the string to the mousetrap lever and the back axle so it winds up and pulls the car forward?</div> <div>■ <b>Reflection:</b> Did the wheels spin in place or grip the floor? How did the length of the string affect how far it went?</div> |
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## Type 2: Material List & Budget

EDP Step: ASK & IMAGINE

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Challenge: \_\_\_\_\_

List the materials you need. If your teacher has set a 'budget' or limit for certain items, write down how many you are taking and the 'cost'.

| Item / Material | Quantity Needed | Cost / Limit | What will it be used for? |
|-----------------|-----------------|--------------|---------------------------|
|                 |                 |              |                           |
|                 |                 |              |                           |
|                 |                 |              |                           |
|                 |                 |              |                           |
|                 |                 |              |                           |
|                 |                 |              |                           |
| TOTALS:         |                 |              |                           |

Before you build, explain WHY you chose these materials.

# Display / Gallery Rubric

Use this rubric to assess student builds during a Makerspace Gallery Walk or when they submit their final prototypes. Each category is worth a maximum of 20 points, for a total of 100 points. The math is designed for easy grading: Exemplary = 20, Proficient = 16, Developing = 12, Beginning = 8.

| Category<br>(20 pts each)               | Exemplary (20 pts)                                                                                                            | Proficient (16 pts)                                                                                                    | Developing (12 pts)                                                                                                  | Beginning (8 pts)                                                                                                         |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <b>Design &amp; Creativity</b>          | Design is highly creative, original, and goes beyond the basic requirements of the challenge. Thoughtful aesthetic choices.   | Design is creative and meets all requirements. Some original ideas are present.                                        | Design meets basic requirements but lacks originality. Aesthetic choices are minimal.                                | Design is incomplete or copies another group exactly. No evidence of creative thought.                                    |
| <b>Construction &amp; Functionality</b> | Build is sturdy, well-constructed, and functions perfectly on the first or second try. Materials are used efficiently.        | Build is functional and mostly sturdy. May require minor adjustments to work properly. Materials are used adequately.  | Build is fragile or only partially functions (e.g., the car moves but veers sharply). Excessive tape/glue used.      | Build does not function or falls apart immediately. Materials were wasted or used incorrectly.                            |
| <b>Process &amp; Problem Solving</b>    | Clear evidence of the EDP. Student iterated at least once, documented failures, and explained how they improved the design.   | Evidence of EDP. Student made changes when the build failed, but documentation of the process is incomplete.           | Some evidence of EDP. Student gave up after first failure or only made cosmetic changes rather than functional ones. | No evidence of the EDP. No iteration or problem-solving documented. Student could not explain their process.              |
| <b>Collaboration &amp; Teamwork</b>     | All team members contributed equally. Roles were shared. Group communicated effectively and resolved conflicts independently. | Most team members contributed. Group communicated well but may have needed minor teacher intervention to stay on task. | Uneven participation (1-2 students did most of the work). Group struggled to communicate or share roles.             | Group had major conflicts. Refused to work together or one student completed the entire project alone without team input. |
| <b>Presentation &amp; Reflection</b>    | Explained the design process clearly. Answered gallery walk questions with detail. Reflection journal shows deep thinking.    | Explained the design adequately. Answered basic questions. Reflection journal is complete but surface-level.           | Struggled to explain the design or how it works. Reflection journal is incomplete or lacks detail.                   | Could not explain the design. Did not participate in the gallery walk. Reflection journal is missing.                     |

| Category                     | Score     |
|------------------------------|-----------|
| Design & Creativity          | ____ / 20 |
| Construction & Functionality | ____ / 20 |