



# ENGINEERING



Welcome to your deck of Family STEM Cards!  
These cards are meant to be a way for the whole family to get involved in STEM and see that STEM happens everywhere!

## HOW THEY WORK:

There are four "suits" of cards, just like a normal deck. In each suit you will find a different theme of activities - **science**, **technology**, **engineering**, or **math**

**A-4 CARDS**  
students Pre-K - 2nd grade

**5-9 CARDS**  
students 3rd - 5th grade

**10- K CARDS**  
students 6th grade and older

Let us know what you think of them by contacting us and include pictures!

## A WRECKING BALL

### POTENTIAL MATERIALS:

- plastic cups
- "ball"
- other household materials
- straws
- string
- tape

### DESIGN CHALLENGE:

Create a wrecking ball out of household items that will knock over a pyramid of cups.

### DESIGN ELEMENTS:

Wrecking balls are made of a heavy materials and hung from a cable/chain which is attached to a tall structure.

### GUIDING QUESTIONS:

1. What might make a good "wrecking ball"?
2. How will you support the weight of the wrecking ball?
3. Besides being tall, what else is needed of your structure?

### ENDING QUESTION:

What element of the system was most important?

### FUN FACT!

Today, wrecking balls are being replaced by high reach excavators!



## 2 PARACHUTE PHYSICS

### POTENTIAL MATERIALS:

- cloth
- plastic bags
- small object
- paper
- string
- scissors

### DESIGN CHALLENGE:

Create a parachute that will allow the object to fall the slowest.

### DESIGN ELEMENTS:

Parachutes are made of a light, strong fabric designed to make heavy objects fall slower.

### GUIDING QUESTIONS:

1. What material could you use as the parachute?
2. How do you need to attach the parachute to the object?
3. What shape/design should the parachute be?

### ENDING QUESTION:

Why do certain materials work better than others as a parachute?

### ACTIVITY EXPLAINED!

Parachutes work because of air resistance. The more of the air's mass the parachute can "catch" the slower it falls.



## 3 SPAGHETTI TOWER

### MATERIALS:

- 20 spaghetti noodles
- 1 yard of string (uncooked)
- 1 yard of tape
- 1 marshmallow

### DESIGN CHALLENGE:

You have 15 minutes to build the tallest possible tower that can support a marshmallow.

### GUIDING QUESTIONS:

1. Spaghetti noodles are very brittle, how can you make them stronger?
2. How will you get your tower to stand on the table?
3. What shapes might be good for building a tower?
4. What is the best way to add the marshmallow to your structure?

### ENDING QUESTION:

What is one thing you would change about your tower and why?

### TRY IT AGAIN!

Try this activity again but have each person make their own tower! Whose tower was the tallest?



## 4 CATAPULT

### POTENTIAL MATERIALS:

- popsicle sticks
- rubber bands
- plastic spoon

### DESIGN CHALLENGE:

Using the materials, design a catapult that will launch a pom pom (or other small object) in the air.

### DESIGN ELEMENTS:

The most common catapult is a "mangonel" which has an arm with a bowl shaped bucket, a frame containing a cross bar to stop the arm, and a mechanism to allow the arm to spring forward.

### GUIDING QUESTIONS:

1. How might you get the arm to spring forward?
2. Where do the arm and frame need to connect?
3. What action do you need to do to launch the catapult?

### FUN FACT!

The first catapults were used in ancient Greece around 399 B.C. They're also a great way to teach Newton's 3 Laws of Motion!



## 5 MARBLE ROLLERCOASTER

### POTENTIAL MATERIALS:

- paper towel/toilet paper tubes
- marbles (or other small balls)
- tape
- scissors

### DESIGN CHALLENGE:

Create a marble rollercoaster out of household items.

### DESIGN ELEMENTS:

Create a rollercoaster track using the wall as support that can transport a marble from the top to the bottom.

### GUIDING QUESTIONS:

1. What materials can be used for the track?
2. How will you attach the track to the wall?
3. Does your track need to be continuous or can there be gaps?

### ENDING QUESTION:

How is this "rollercoaster" different than rollercoasters at amusement parks?

### EXTENSION!

Have a lot of materials? Form two teams and create two rollercoasters and race. Discuss why one design was better than the other?



## 6 SUSPENSION BRIDGE

### POTENTIAL MATERIALS:

- Cereal box
- toilet paper tubes
- twine/string
- tape
- rubber bands

### DESIGN CHALLENGE:

Create a suspension bridge that holds the weight of a toy car.

### DESIGN ELEMENTS:

A suspension bridge is a deck (the road) with cables hanging from tall towers. Typically, there is a long cable suspended horizontally between the towers with vertical cables connected from it to the deck.

### GUIDING QUESTIONS:

1. How will you affix the bridge to the floor?
2. How will you connect the cables to the deck?
3. Do your cables need slack or should they be taut?
4. How will your car drive onto the bridge?

### HOW IT WORKS!

The weight of the deck is supported by the balanced forces of the two towers. The force pulling inwards is equal to that pulling outwards.



## 7 PENNY BOATS

### MATERIALS:

- Foil
- Shallow Bin
- Pennies
- Water

### DESIGN CHALLENGE:

Construct a boat from an aluminum foil square that can hold as many pennies as possible.

### STEPS:

1. Cut the foil into a square that is between 4" by 4" and 12" by 12".
2. Shape your foil square into a boat. You can create your own design or use a specific boat as inspiration.
3. Fill your bin with at least 4" of water.
4. Make a prediction! How many pennies do you think your boat will hold?
5. Take turns placing one penny in the boat at a time until it sinks.

### ENDING QUESTION:

How would your result change if your boat was bigger? Smaller?

### CONCEPT EXPLORATION!

This activity looked at buoyancy and water displacement. See what you can learn about them!

L

## 8 EGG DROP!

### POTENTIAL MATERIALS:

- egg
- sponges
- straws
- other household materials
- cardboard
- cotton balls
- tape

### DESIGN CHALLENGE:

Have each family member create a container that will keep a raw egg safe when it is dropped from a height.

### DESIGN ELEMENTS:

Keeping the egg safe means finding a way to pad its fall or slow it down enough so it won't crack. Many designs find ways to cover the egg so it doesn't make direct contact with the ground.

### GUIDING QUESTIONS:

1. What items could be used as padding?
2. How will you secure the egg while it falls?
3. How could you slow down the egg when it is falling?
4. How might height affect this experiment?

### CHALLENGE YOURSELF!

Do this activity again but with extra rules. Examples: Use the least amount of materials, design in 5 minutes, etc..

8

## 9 BALLOON CARS

### POTENTIAL MATERIALS:

- cardboard
- balloons
- paper plates
- toilet paper tubes
- straws
- tape
- string
- glue

### DESIGN CHALLENGE:

Each family member must create a car with wheels that roll and a balloon "engine."

### DESIGN ELEMENTS:

The most important design aspects of the car are the wheels, axle, body, and the balloon.

### GUIDING QUESTIONS:

1. How will you attach the axle/wheels so the car rolls?
2. Where is the best place to put the balloon? How will you attach the balloon?
3. What will you use for the wheels?
4. Where is the best place for you to race?

### FUN FACT!

The average car has 1,800 separate parts and requires between 4,500 - 4,800 welds to fit together! How about your car?

6

## 10 BASKETBALL TOWER

### MATERIALS:

- newspaper
- masking tape
- basketball

### DESIGN CHALLENGE:

Build a tower out of newspaper and masking tape that will support a basketball.

### DESIGN ELEMENTS:

The tower must be able to stand by itself and hold the weight of the basketball for one minute.

### GUIDING QUESTIONS:

1. How will you get the tower to stand?
2. How will you get the basketball to balance on your tower?
3. How can you manipulate the newspaper to make it stronger?

### EXTEND THE ACTIVITY!

Newspaper is a lot stronger than you think. See if you can design a newspaper stool that will hold your weight.

10

## J DIY TRAMPOLINE

### POTENTIAL MATERIALS:

- colander
- rubber bands
- tape
- plastic bag
- tooth picks
- binder clips
- ball
- fabric

### DESIGN CHALLENGE:

Create a trampoline together that will be able to bounce a ball at least 8 inches.

### DESIGN ELEMENTS:

Trampolines have a thicker, stretchy material, springs that attach it to a frame.

### GUIDING QUESTIONS:

1. How do trampolines work? What is important to make sure your design has?
2. How will you connect your fabric to the frame?
3. What will you build your frame out of?

### CONCEPT EXPLORATION!

Trampolines apply Hooke's Law of Physics. The law states the amount of force you exert on a spring, the equal amount will be returned. Learn more about it!

r

## Q MISSION SPACE LANDER

### POTENTIAL MATERIALS:

- index cards
- marshmallows
- other household materials
- paper
- straws
- dixie cups

### DESIGN CHALLENGE:

Design and build a shock-absorbing lander to protect two "aliens" (marshmallows) as they crash from 2 feet in the air.

### DESIGN ELEMENTS:

The space lander must have legs that allow it to stand when dropped and keeps the marshmallows contained.

### GUIDING QUESTIONS:

1. How might you absorb the impact of the fall?
2. What will your structure look like? You can research what the Mars Rover looks like as inspiration.
3. What part does weight distribution play in your design?

### LEARN MORE!

NASA Jet Propulsion Laboratory created a video to describe the challenges of landing the Curiosity rover on Mars. Google it!

Q

## K FOOSBALL TABLE

### POTENTIAL MATERIALS:

- cardboard
- wooden dowels
- ping pong balls
- rubber bands
- other household materials
- straws
- paper
- pencils
- tape

### DESIGN CHALLENGE:

Construct a functioning foosball table that has at least 12 players and 6 rods with a goal at each end.

### DESIGN ELEMENTS:

Foosball tables have rods that push, pull, and turn to control the players which are secure so they don't fall off when they hit the ball. The player can hit the ball on either side.

### GUIDING QUESTIONS:

1. What could you use for the rods?
2. How will you attach the players so they can move on the rod?
3. What material is strong enough to "kick" the ball?

### FUN FACT!

The longest game of foosball ever took 61 hours and 17 minutes. That's over two days of playing!

K

## greater cincinnati STEM collaborative

The Greater Cincinnati STEM Collaborative (GCSC) is the backbone K-12 STEM education nonprofit on a mission to create a robust STEM pipeline of diverse talent to meet the accelerating demands for STEM jobs in our regions. GCSC connects business, education, and community partners together to create hands-on learning experiences which prepare students to be the innovators and problem solvers of tomorrow.

In collaboration with schools and educators, GCSC supports the following programs:

- 3d Printers Club
- STEM Bicycle Club
- Summer of STEM
- Garden Engineers
- Game On!

To learn more about GCSC and how you can get involved, visit us at:

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