All-inclusive planning guide and activities for a successful STEM Family Night!

Elementary & Middle School

8 STEM Stations

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This all-inclusive STEM Family Night Planning Guide has everything you need to host a successful STEM Night! The guide was created after hosting several successful STEM Family Nights with over 350 participants. The activities have been vetted by math and science teachers for both elementary and middle school participants and their families. We hope this guide will give you the confidence to host your own amazing STEM Family Night!

Planning Guide Includes:

- Overview including step-by-step planning instructions
- STEM Night Planning Checklist
- Budget including links to materials
- Editable Marketing Materials
- 8 STEM Night Challenges that include
  - Materials required
  - Teacher instructions
  - Station Sign
  - Participant hand-outs
  - Pictures of activity in action
- Engineering Design Process Poster
- Editable STEM Night Passport
Purpose of a STEM Night

• Generate excitement for STEM by letting families explore STEM together
• Encourage a school culture of STEM and project-based learning
• Increase community understanding of STEM education and career pathways

Audience

The STEM Night stations outlined in this product have been used for both elementary and middle school STEM Nights. Stations were designed to engage all ages including students, parents, and siblings. Some stations may be a little challenging for younger students, but the purpose is to encourage parent involvement to support learning.

Description

STEM Family Night is an evening of hands-on science, math, and engineering activities for students and families to complete together. The event includes a range of activities covering different topics and connections to various careers. STEM activities can tie into a selected theme or connect with relevant science and math standards.

Step 1 – Get support

A STEM Family Night can be a big undertaking and requires support from school administration and teachers. A successful night requires full support from the principal and school administration especially for event logistics. Reaching out to the math and science departments is important for recruiting teacher volunteers and advertising to students. Teachers and staff can also support to welcome visitors, prepare stations, or support other logistics.

Additional support can be found from:

• Local engineering companies for sponsors, volunteers, or raffle prizes.
• Local universities with science and engineering departments: many have STEM outreach programs that would be happy to lead a STEM station or provide engineering students as volunteers.
• Parent volunteers to help prepare activities, fundraising, and supporting the night of the event.
• High school STEM organizations such as robotics clubs to volunteer in stations or bring demonstrations.
Step 2 – Choose Activities
Choose activities in advance to allow teachers to sign-up for stations and use in advertising. Plan for about 6 – 8 stations spread throughout the cafeteria or school depending on expected participation.

**Recommended for stations:**
- Quick, hands-on activity
- Accessible to all ages
- Opportunity to design and build
- Requires a short list of readily available materials
- Wide-range of topics covered

**NOT Recommended for stations:**
- Talks or presentations
- Displays from companies that don’t include a hands-on component
- Overly time-consuming or extensive activities with multiple steps
- Same type of activities for all stations

Make sure to provide a wide selection of activities to cater to a wide range of student interests. Also ensure there are enough activities so families don’t have to wait too long at each station to get involved. For a first STEM Night, aim for 6 – 8 stations that allow for many participants at once. For example, for the Build A Boat station, set-up several containers for testing aluminum foil boats to allow several families to participate.

Step 3 – Determine Date and Time
STEM Nights vary from school to school depending on school culture and family engagement. A STEM Night should not exceed more than 2 hours and is recommended to be an open event for all students and family members.

**Option 1**
4:00 – 4:30: Students meet afterschool in library and listen to a motivational STEM guest speaker
4:45 – 5:45: Families arrive and join students in cafeteria, receive STEM Passport, and engage in STEM activities
5:45 – 6:00: Stations end and raffle winners are announced

**Option 2**
6:00 – Families arrive and receive STEM Passport and engage in STEM activities
7:15 – End of stations and announce raffle winners

**Things to Consider:**
- Is transportation an issue for students?
- Will food be provided?
- Do families need to RSVP?
- When are teachers available?
Step 4 – Location

Determine the best location in your school to hold STEM Stations. These can be held in one large open space or spread across the school. Using multiple locations will feel like a scavenger hunt to participants who will use the STEM Passport to find the stations. The downside is not having as much control of participants. To manage traffic, you can blockaded hallways, post signs, and assign volunteers to direction traffic. Keep in mind that some activities may be better suited for a small enclosed space so a teacher can more closely monitor and guide families. One example is the Computer Animation station that requires access to computers.

A large open space such as a cafeteria is a great place to host the majority of activities. Excitement will be contagious as many students are engaged in various activities. Set-up stations along the perimeter of the room to allow for flow of traffic. Add some extra seating area for elderly or young children.

Make a diagram of activities and present to administration and custodial staff who will be setting up. Don’t forget to create a welcome area where volunteers will monitor sign-in sheets, provide STEM Passports, and direct families. You may also wish to include a refreshments table.

Step 5 – Publicize Event

Publicize the event through the school website, flyers, phone calls, and announcements. Teacher volunteers can talk about the event during class, and they may even wish to have a STEM lesson the day of the event for a school-wide STEM Day. For marketing, include a timeframe and list some of the specific activities. You may also wish to invite local media. Incentives for attendance can include:

- **Refreshments**: Students can be rewarded with a food ticket upon completing a set number of activities. We rented a food truck with kettle corn and slushies and required students to complete 2 stations to get a food ticket. It was a huge hit!
- **Raffle Prizes**: Participants can receive raffle tickets for each completed station
- **Extra credit**: Teachers can provide extra credit for attending event. The STEM Passport can be checked for number of completed activities.
**Step 6 – STEM Passport**

Once the location and activities are solidified, you will need to make a STEM Passport. This will act as a map for participants, and they will receive a stamp for each completed station. A passport is a great tool to keep participants engaged the whole night. It can also be used for raffle tickets, extra credit, or to receive a food ticket with completed number of stations.

*For each station:*

- Recruit teachers comfortable with the subject area.
- Create a sign to mark the station. One possibility is a tri-fold board (shown below) that includes a scientific explanation and career connections.
- Optional – provide hand-outs for participants to complete the activity at home or learn more.
- Practice the station beforehand.
- Provide teachers with stamps or stickers to mark the STEM Passport.
- Ensure there is enough space for activities.
- Provide enough supplies for the expected number of participants.
This checklist is a suggested list of actions for a successful STEM Night. Every night looks different depending on your specific event. It is recommended to start the planning process at least 2 – 3 months prior to the event.

- Determine date and time
- Meet with principal or appropriate school administration
- Select 6 – 8 STEM Activity Stations
- Assign 2 – 3 teachers per station and provide with instructions beforehand
- Recruit 3 – 5 STEM Night general volunteers
- Ask for sponsors or presenters from local STEM organizations and universities
- Create a timeline of events and volunteer assignments
- Create a STEM Passport and sign-in sheets and make copies
- Draw a diagram of STEM Night layout and present to admin and custodial staff
- Hold a meeting with all STEM Night volunteers and teachers a few days prior to the event
- Make STEM Night flyers or announcements to advertise event
- Create STEM Night signs for the event to mark each station and direct traffic
- Purchase materials and prepare activities in separate bins
- Make parent phone calls about STEM Night
- Set-up stations and welcome tables
- Assign a photographer to capture event
Below is a recommended list of STEM Family Night station activities along with the topics covered. This product includes teacher instructions, station posters, and participant hand-outs for these activities.

<table>
<thead>
<tr>
<th>Station</th>
<th>Topics Covered</th>
<th>Overview</th>
<th>Min. Volunteers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blobs In A Bottle</td>
<td>Density</td>
<td>Create colorful blobs using vegetable oil, food coloring, and water in a take-home soda bottle.</td>
<td>3</td>
</tr>
<tr>
<td>Build a Mighty Machine</td>
<td>Potential &amp; Kinetic Energy, Graphing</td>
<td>Build a catapult using the stored elastic energy of rubber bands.</td>
<td>1</td>
</tr>
<tr>
<td>Heart Rate Math</td>
<td>Percentage, Graphing, Cardiovascular System</td>
<td>Measure and graph heart rate after performing various exercises.</td>
<td>2</td>
</tr>
<tr>
<td>Build A Boat</td>
<td>Density, Surface Area, Buoyancy, Engineering</td>
<td>Build an aluminum foil boat to hold as much weight as possible.</td>
<td>2</td>
</tr>
<tr>
<td>Straw Rockets</td>
<td>Engineering, Newton's Laws, Force &amp; Motion</td>
<td>Build a straw rocket with nose cone and fins to hit a target.</td>
<td>3</td>
</tr>
<tr>
<td>Space Docking Team Building Activity</td>
<td>Newton's Laws, Force &amp; Motion, Communication</td>
<td>Team-building activity to move a ball to a designated spot.</td>
<td>1</td>
</tr>
<tr>
<td>Computer Animation</td>
<td>Programming, Communication</td>
<td>Create a fun video game and learn the basics of programming.</td>
<td>1</td>
</tr>
<tr>
<td>Mural Creation Station</td>
<td>Communication</td>
<td>Draw or write something related to the selected STEM theme.</td>
<td>1</td>
</tr>
</tbody>
</table>

Additional volunteers are needed for managing welcome table, directing traffic, managing refreshments, and taking pictures.
Below is a STEM Night Budget for an expected turnout of 350 participants including students and family members. Each station is stocked with enough materials for about 100 participants. Budgets can be adjusted according to number of participants, already available supplies, and funding available. Organizers may wish to request supply donations from parents or local companies.

<table>
<thead>
<tr>
<th>Station</th>
<th>Materials</th>
<th>Description</th>
<th>URL</th>
<th>Quantity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Stations</td>
<td>Ink Pads &amp; Stamps</td>
<td>Ink pad and 2 stamps per station</td>
<td>Oriental Trading</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td></td>
<td>Plastic Bins</td>
<td>18 Gallon, set of 8</td>
<td>Walmart</td>
<td>1</td>
<td>$40</td>
</tr>
<tr>
<td>Mighty Machine</td>
<td>Rubber Bands</td>
<td>Assorted</td>
<td>Walmart</td>
<td>2</td>
<td>$4</td>
</tr>
<tr>
<td></td>
<td>Craft Sticks</td>
<td>300 pieces</td>
<td>Amazon</td>
<td>2</td>
<td>$10</td>
</tr>
<tr>
<td></td>
<td>Plastic spoons</td>
<td>100 pack</td>
<td></td>
<td>1</td>
<td>$5</td>
</tr>
<tr>
<td></td>
<td>Garbanzo Beans</td>
<td>1 pack</td>
<td></td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>Blobs In A Bottle</td>
<td>Food Coloring</td>
<td>Assorted Food Colors</td>
<td>Walmart</td>
<td>8</td>
<td>$30</td>
</tr>
<tr>
<td></td>
<td>Alka-Seltzer</td>
<td>116 tablets</td>
<td>Amazon</td>
<td>1</td>
<td>$15</td>
</tr>
<tr>
<td></td>
<td>Funnels</td>
<td>Medium funnel</td>
<td>Walmart</td>
<td>5</td>
<td>$5</td>
</tr>
<tr>
<td></td>
<td>Vegetable Oil</td>
<td>1 gallon</td>
<td>Sam’s Club</td>
<td>5</td>
<td>$40</td>
</tr>
<tr>
<td></td>
<td>Soda Bottles</td>
<td>12 oz. soda bottles</td>
<td>Sam's Club</td>
<td>4</td>
<td>$40</td>
</tr>
<tr>
<td>Build A Boat</td>
<td>Washers</td>
<td>¼ in 100 pack</td>
<td>Amazon</td>
<td>2</td>
<td>$20</td>
</tr>
<tr>
<td></td>
<td>Aluminum Foil</td>
<td>75 sq ft</td>
<td>Walmart</td>
<td>1</td>
<td>$3</td>
</tr>
<tr>
<td>Space Docking</td>
<td>PVC Female Adapter</td>
<td>3 in. PVC DWV Hub x FIPT Female Adapter</td>
<td>Home Depot</td>
<td>2</td>
<td>$4</td>
</tr>
<tr>
<td></td>
<td>PVC Spigot x Female Adapter</td>
<td>4 in. PVC DWV Street Spigot x FIPT Female Adapter</td>
<td>Home Depot</td>
<td>2</td>
<td>$16</td>
</tr>
<tr>
<td></td>
<td>Rope</td>
<td>75 ft Poly Cord</td>
<td>Home Depot</td>
<td>2</td>
<td>$6</td>
</tr>
<tr>
<td></td>
<td>Ball</td>
<td>Try different sizes</td>
<td>Academy</td>
<td>2</td>
<td>$10</td>
</tr>
</tbody>
</table>
# STEM Family Night Budget

<table>
<thead>
<tr>
<th>Station</th>
<th>Materials</th>
<th>Description</th>
<th>URL</th>
<th>Quantity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw Rockets</td>
<td>Rocket Launcher</td>
<td>1 rocket launcher</td>
<td>Pitsco</td>
<td>1</td>
<td>$170</td>
</tr>
<tr>
<td></td>
<td>Scotch Tape</td>
<td>6 rolls</td>
<td>Sam’s Club</td>
<td>2</td>
<td>$6</td>
</tr>
<tr>
<td></td>
<td>Modeling Clay</td>
<td>5 pounds</td>
<td>Walmart</td>
<td>1</td>
<td>$8</td>
</tr>
<tr>
<td></td>
<td>Index Cards</td>
<td>100 ct</td>
<td></td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td></td>
<td>Scissors</td>
<td></td>
<td></td>
<td>12</td>
<td>$20</td>
</tr>
<tr>
<td></td>
<td>Straws</td>
<td>Straight drinking straws</td>
<td>HEB</td>
<td>1</td>
<td>$3</td>
</tr>
</tbody>
</table>

| Miscellaneous | $15 |

**Total Cost: $500**

## Not Included In Budget
- Pens and pencils
- Stopwatches
- Calculators
- Drink Cooler
- Containers for Blobs and Build A Boat
- Paper towels
- Markers

## Tight Budget? $330 Version

I highly recommended the Pitsco Straw Rocket Launcher as it can be used for multiple events and classroom activities. However, you can try an alternate activity with only straws and paper --

- [Kids Science Soda Straw Rocket](https://www.youtube.com/watch?v=Q9zJiz0h6zE)
<table>
<thead>
<tr>
<th>Pages</th>
<th>Station</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Engineering Design Process Poster</td>
<td>Print out and include as handout or on station posters</td>
</tr>
<tr>
<td>14 - 16</td>
<td>Blobs In A Bottle</td>
<td>Create colorful blobs using vegetable oil, food coloring, and water in a take-home soda bottle.</td>
</tr>
<tr>
<td>17 – 19</td>
<td>Build a Mighty Machine</td>
<td>Build a catapult using the stored elastic energy of rubber bands.</td>
</tr>
<tr>
<td>20 - 23</td>
<td>Heart Rate Math</td>
<td>Measure and graph heart rate after performing various exercises.</td>
</tr>
<tr>
<td>24 - 26</td>
<td>Build A Boat</td>
<td>Build an aluminum foil boat to hold as much weight as possible.</td>
</tr>
<tr>
<td>27 - 30</td>
<td>Straw Rockets</td>
<td>Build a straw rocket with nose cone and fins to hit a target.</td>
</tr>
<tr>
<td>31 - 34</td>
<td>Space Docking Team Building Activity</td>
<td>Work in a team to move a ball balanced on a cylinder into a larger cylinder on the ground.</td>
</tr>
<tr>
<td>35 - 36</td>
<td>Computer Animation</td>
<td>Create a fun video game and learn the basics of programming.</td>
</tr>
<tr>
<td>37</td>
<td>Mural Creation Station</td>
<td>Draw or write something related to the selected STEM theme.</td>
</tr>
</tbody>
</table>
ENGINEERING DESIGN PROCESS

1. Identify the Problem
2. Brainstorm
3. Design
4. Build
5. Test & Evaluate
6. Redesign
7. Share Solution
Blobs In A Bottle
Blobs In A Bottle
Create colorful blobs using vegetable oil, food coloring, and water in a soda bottle.

MATERIALS PER PARTICIPANT
- 12 oz. soda bottle per participant
- 3 oz. water (large water cooler)
- 1 cup vegetable oil
- Alka-Seltzer tablet
- 10 drops food coloring
- Optional: Measuring cups
- Containers
- Paper towels

INSTRUCTIONS:
Teachers can lead a group of participants through the activity or can guide one participant at a time. This depends on how much supervision is required for participants. Parents can help younger students with pouring liquids.

1. Pour out and rinse all soda bottles. Soda can be added to a cooler for use during the event.
2. Fill empty bottle with about ¼ water from the cooler.
3. Place bottle into a container to catch any spilled liquids. Use a funnel to carefully pour vegetable oil into the bottle until it is almost full. Teachers can also fill measuring cups with 1 cup vegetable oil and then allow students to pour.
4. Add 10 drops of liquid food coloring to the bottle. The drops will pass through the oil into the water.
5. Break Alka-Seltzer tablet in half and drop into the bottle. Watch it sink and let the blobby greatness begin!

EXPLANATION:
Why do water and oil separate from each other? The oil stays above the water because the oil is lighter than the water or, more specifically, less dense than water.

Why does the food coloring mix with water? Food coloring is mostly water and is therefore the same density as water making it sink through the oil.

How does the color mix when you add fizzing tablets? The tablet sinks to the bottom and starts dissolving and creating a gas. As the gas bubbles rise, they take some of the colored water with them. When the blob of water reaches the top, the gas escapes and down goes the water.
Why do water and oil separate from each other? The oil stays above the water because the oil is lighter than the water or, more specifically, less dense than water.

Why does the food coloring mix with water? Food coloring is mostly water and is therefore the same density as water making it sink through the oil.

How does the color mix when you add fizzing tablets? The tablet sinks to the bottom and starts dissolving and creating a gas. As the gas bubbles rise, they take some of the colored water with them. When the blob of water reaches the top, the gas escapes and down goes the water.
Build A Mighty Machine

Use stored elastic energy in rubber bands to build a catapult.
Build A Mighty Machine
Use the stored elastic energy of rubber bands to make a catapult.

MATERIALS PER PARTICIPANT
- Plastic spoon
- 5 – 10 rubber bands
- 3 – 6 jumbo craft sticks
- Beans / Ping Pong Balls / Small object

INSTRUCTIONS:
1. Set-up a launching zone. Teachers may wish to use measuring tape to measure distance, a target to hit, or a tower of cups to knock over.
2. Explain the difference between kinetic and potential energy. Explain how winding or stretching rubber bands is a great way to store elastic energy.
3. Provide participants with supplies and explain that their mission to build a catapult to launch an object using the stored elastic energy of rubber bands. When launching, their catapult must be touching the ground / surface at all times.
4. Allow students to test catapult designs.

EXPLANATION:
Potential energy is the energy that an object has because of its position, also thought of as stored energy. Kinetic energy is the energy an object has because of its motion.
Elastic potential energy is a form of potential energy that occurs when some objects are deformed. Any object that can be deformed and then return to its original shape can have elastic potential energy. Examples include rubber bands, sponges, and bungee cords. When you deform these objects they move back to their original shape on their own. As a counter-example, an object that would not be affected by elastic potential energy would be something like a sheet of aluminum foil. If you crumple a sheet of it into a ball it won't change back into a sheet when you let go.

STEM CAREER CONNECTION:
Mechanical engineers are concerned about the mechanics of energy — how it is generated, stored and moved. Engineers apply the principles of potential and kinetic energy when they design consumer products. For example, a pencil sharpener employs mechanical energy and electrical energy. When designing a roller coaster, mechanical and civil engineers ensure that there is sufficient potential energy (which is converted to kinetic energy) to move the cars through the entire roller coaster ride.
Elastic potential energy is a form of potential energy that occurs when some objects are deformed. Any object that can be deformed and then return to its original shape can have elastic potential energy. Examples include rubber bands, sponges, and bungee cords.

**STEM Career Connection:** Mechanical engineers are concerned about the mechanics of energy — how it is generated, stored and moved. They apply the principles of potential and kinetic energy when they design consumer products. For example, a pencil sharpener employs mechanical energy and electrical energy. When designing a roller coaster, mechanical and civil engineers ensure that there is sufficient potential energy (which is converted to kinetic energy) to move the cars through the entire roller coaster ride.
**MATERIALS:**

- Stop watch
- Pencils
- Heart Rate Math Handout
- Calculators

**INSTRUCTIONS:**

1. Find your pulse. To find a pulse on the side of your neck, place two fingers in the space between the windpipe and the large muscle in the neck which is below your ear. Press lightly until you feel a pulse.

2. First, we need to measure your resting heart rate while you are calmly sitting. Set a timer for 15 seconds or watch the clock. For 15 seconds, count the number of heart beats. This is your *Resting Heart Rate*.

3. Next, stand up. Measure your pulse again for 15 seconds.

4. Continue filling out your heart beats for the activities. Make sure to measure your pulse immediately after the activity for accurate results.

5. A common way to record heart rate is in beats per minute. Convert your recorded number of heart beats into beats per minute (bpm). Hint: You measured beats per 15 seconds. How many seconds in a minute?

6. Let’s see how much your heart rate increased. Calculate the percentage increase for each activity compared to your Resting Heart Rate. Ex: Going from 100 bpm to 120 bpm is a 20% increase. Round to nearest tenth. (This is optional and can be completed at home).

7. Follow the steps to determine Target Heart Rate. This is the rate athletes want to maintain for an effective workout.

8. Ask participants to complete the back at home including graphing the results.
HEART RATE MATH

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of heart beats in 15 seconds</th>
<th>Beats per minute (Multiply by 4)</th>
<th>Percentage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting = Resting Heart Rate</td>
<td></td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Standing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk in place for 30 steps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Jumping Jacks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 Fast High Knees</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Determine your maximum heart rate (MHR). This is the highest your heart rate should reach during high intensity exercise. MHR is found by subtracting your age from 220. For example, for a 20 year old, the MRH is 220 – 20 = 200 beats per minute (bpm).

\[
\text{My Maximum Heart Rate} = 220 - \frac{\text{My Age}}{20} = \text{bpm}
\]

2. For moderate-intensity physical activity, a person's target heart rate should be between 50 to 70% of his or her maximum heart rate. Find your target heart rate:

<table>
<thead>
<tr>
<th>20 Year Old</th>
<th>You</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% of MHR</td>
<td>100</td>
</tr>
<tr>
<td>70% of MHR</td>
<td>140</td>
</tr>
</tbody>
</table>
Let’s graph our data! Sports scientists often graph the heart rate of athletes performing different exercises to determine how effective they are in raising their heart rate. Create a bar graph for each different activity.

**HEART ❤ RATE GRAPH**

<table>
<thead>
<tr>
<th>Beats Per Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
</tr>
<tr>
<td>140</td>
</tr>
<tr>
<td>120</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

**Sitting**  **Standing**  **Walking**  **Jumping Jacks**  **High Knees**

**CAREER CONNECTION**

**Biomechanist** – Biomechanics is the study and explanation of the laws of physics as applied to physical activity. Biomechanics can be used to explain how muscles, bones, and joints are injured under certain conditions. One example is understanding what happens to the brain of a football player when hit by another player. This understanding will improve how we treat traumatic head injuries and long term effects from concussions. Also, their understanding of the human body can lead to improved exercises that allow athletes to run faster or jump higher. Biomechanists typically hold a bioengineering, biology, or mechanical engineering degree.

**Sports Engineer** – Sports engineers combine a passion for engineering and sports! A sports engineer combines an understanding of physics, biology, and engineering to improve sports equipment and enhance athletic performance. For example, sports engineers designed a better golf club for Tiger Woods, basketball shoes for Michael Jordan, or a swim suit for Michael Phelps. They also decreased athletic injuries by designing better helmets or shoulder pads. A sports engineer typically holds a bioengineering, mechanical engineering, or material science degree.
Build A Boat

Station

Build a boat out of aluminum foil to hold as many weights as possible.
Build A Boat

Make a boat out of aluminum foil to hold as much weight as possible.

**MATERIALS:**

- Aluminum foil: 75 sq. ft. roll per 100 participants
- Bins of water: large Tupperware or plastic mixing bowls
- Washers for weights: 1/4 in pack of 100
- Paper towels for clean-up
- Hand-outs for participants
- Ruler to measure aluminum foil squares

**INSTRUCTIONS:**

1. Determine a location that is suitable for getting wet!

2. Provide each student with a 6 in x 6 in sheet of aluminum foil. Make this by cutting one foot of aluminum foil and dividing into fourths.

3. Ask participants to build a boat with the sheet of foil to float as many washers as possible.

4. Float the boat in a tub of water and add washers one at a time into the boat until it sinks.

5. Ask family members to compete and see who can build the boat to hold the most weight! This is a great way to engage all family members.

**EXPLANATION:**

What are the forces on a boat? **Gravity** is pulling it downward, determined by the weight of the boat. **Buoyancy** is pushing it upward. The buoyancy force is created by the weight of the water displaced by the boat.

Alternate explanation - When an object is in the water, gravity pulls the object down and displaces some of the water, which means some of the water is pushed aside. Gravity pulls the displaced water down, and causes an upward force on the object, called buoyancy. The amount of water displaced depends upon the volume of the object. A higher volume causes more fluid to be displaced, which means more buoyancy.

**STEM CAREER CONNECTION:**

Boat designers have to consider buoyancy as well as friction when deciding on the shape of a boat’s hull. A boat designed for speed must have enough displacement to stay afloat, but surface area has to be minimized to decrease the effects of friction. On the other hand, an object designed to carry a heavy weight, such as a cargo ship, must be designed with greater displacement.

Marine engineers and naval architects design, build, and maintain ships from aircraft carriers, submarines, sailboats, and tankers. Marine engineers work on the mechanical systems, such as propulsion and steering. Naval architects work on the basic design, including the form and stability of hulls.
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**STEM Career Connection:** Marine engineers and naval architects design, build, and maintain ships from aircraft carriers, submarines, sailboats, and tankers. Marine engineers work on the mechanical systems, such as propulsion and steering. Naval architects work on the basic design, including the form and stability of hulls.
Straw Rockets Station
Straw Rockets

Build a rocket with nose cone and fins to hit a target

**MATERIALS:**

- Pitsco Straw Rocket Launcher
- Target
- Straight straw
- Index card
- Modeling Clay (1/2 in diameter)
- Scotch tape
- Optional: pencil and ruler for drawing fins

**INSTRUCTIONS:**

Build a straw rocket using provided materials to hit a target on the wall. The launcher will be set at 45 degrees and launched at 24 cm (marked on launcher). Students determine fin shape, number of fins, rocket length, and nose cone shape. The mission is to hit a target on the wall. This should be placed approximately 10 feet away and be about 2 ft x 2 ft (or larger).

**Building A Rocket:** During the event, students can be provided step-by-step instructions or shown an example rocket and allowed to figure out the steps.

1. Draw the chosen fin shape on an index card, drawing as many fins as needed for the rocket design. Students can skip this step and just cut directly.
2. Cut the fins out of the index card. The fins should all be the same size and shape.
3. Cut the straw to the desired length with the scissors.
4. Cut a piece of tape as long as the edge of the fin that is to be connected to the rocket body or straw. Place the tape on the edge of one fin. Repeat this for all fins. Attach the fins so they are evenly spaced around the straw. Trim off any excess tape using the scissors.
5. Knead the clay to soften it. Carefully shape the clay to match the desired nose cone shape. The surface of the nose cone needs to be smooth. Press the nose cone on top of the straw rocket body, making sure the nose cone is centered. The outside edge between the straw and nose cone should be sealed carefully with the clay.
6. Launch the straw rocket using the Pitsco Straw Rocket Launcher. If you miss the target, what can you change on the rocket to alter the distance traveled?

**Straw Rocket Variables:** Length of straw, nose cone mass, size and shape of fins, amount of air pressure, angle of launcher
Factors to Consider:

- Symmetry: Ensure the rocket fins are symmetric to ensure a straight flight
- Aerodynamics: Make sure the rocket shape is streamlined to decrease drag
- Weight: The heavier a rocket, the shorter the flight

EXPLANATION:
The basics of rocketry is centered on Newton’s Third Law: For every action, there is an equal and opposite reaction. When you drop the bar, air is being pushed through the metal tube and into the straw rocket. The force of air pushes the rocket forward. The action is the air being pushed into the rocket. The reaction is the rocket moving forward.

What are the forces acting on the rocket?

- **Weight**: The force of gravity due to the weight of the rocket pulls down on the rocket.
- **Drag**: Also known as air resistance, this is the downward friction force created by the surround air.
- **Thrust**: The upward propulsive force of a rocket engine to overcome the forces of weight and drag.

STEM Career Connection:
Aerospace Engineering is the field of engineering surrounding the development and testing of aircraft and space craft. Aerospace Engineers develop airplanes, helicopters, satellites, missile systems, propulsion systems, high-tech Unmanned Air Vehicles, and more.
According to Newton’s Third Law, for every action, there is an equal and opposite reaction. For a straw rocket, the action is the air being pushed into the rocket. The reaction is the rocket moving forward.

**Forces on a rocket?** The weight of the rocket due to gravity pulls downward. Drag, or air resistance, is the downward friction force created by the surrounding air. Thrust is the upward propulsive force of a rocket engine.

**STEM Career Connection:** Aerospace Engineering is the field of engineering surrounding the development and testing of aircraft and space craft. Aerospace Engineers develop airplanes, helicopters, satellites, missile systems, propulsion systems, high-tech Unmanned Air Vehicles, and more.
Space Docking Station
Safely dock your space craft to the International Space Station.

MATERIALS FOR ONE SPACE DOCKING STATION:
- 40 feet rope
- Ball: The larger and heavier the ball the easier the task
- 3 in. PVC DWV Hub x FIPT Female Adapter
- 4 in. PVC DWV Street Spigot x FIPT Female Adapter
- Drill and scissors (to build space docking set)

INSTRUCTIONS:

To build one space docking station:
1. Drill 8 evenly spaced holes into the 3 inch PVC adapter as shown in diagram on next page.
2. Cut rope into 5 foot sections. Pass each piece through a hole and double knot. Burn ends to prevent fraying.

During event:
1. Explain the process of space docking to the International Space Station.
2. Split participants into teams of 8. Encourage all family members to participate.
3. Each participant holds onto the end of a rope.
4. Place the ball onto the PVC adapter as it rests on the ground. The ball is your astronauts inside the Space Shuttle. The PVC adapter is your docking port.
5. As a team, move your ball and cylinder and place into the larger cylinder on the floor.

Hints for struggling teams: Start with everyone tightly holding onto the rope and the PVC pipe suspending securely. Then place the ball onto the cylinder. Ask everyone to hold onto the rope closer to the cylinder. Ask another participant to act as navigator.

EXPLANATION:

Docking specifically refers to joining of two separate free-flying space vehicles. Astronauts enter the International Space Station using docking ports. The ports allow visiting spacecraft to connect to the space station. The crew members use the ports to move supplies onto the station.

The International Space Station is a unique place – a convergence of science, technology and human innovation that demonstrates new technologies and makes research breakthroughs not possible on Earth. It is a microgravity laboratory in which an international crew of six people live and work while traveling at a speed of five miles per second, orbiting Earth every 90 minutes. The space station has been continuously occupied since November 2000. In that time, more than 200 people from 15 countries have visited. Crew members spend about 35 hours each week conducting research in many disciplines to advance scientific knowledge in Earth, space, physical, and biological sciences for the benefit of people living on our home planet.
In the 3 inch PVC adapter, drill 8 holes. There are 8 ridges evenly spaced around the adapter to use as guide.

4 inch PVC adapter represents the ISS.
EXPLANATION CONTINUED

Forces make things move or make things change their motion. Force is a push or pull in a particular direction. More than one force can act on an object at a time. The forces can push or pull in any direction. What happens to the object when the forces act depends on how strong the forces are and the direction of the forces.

The ball will move depending on the force each person places on the string.

If two forces of equal strength act on an object in opposite directions, the forces will cancel, resulting in a net force of zero and no movement. If the effects of the forces don't cancel each other, if one force is stronger than others, the forces are unbalanced forces. Unbalanced forces cause a change in motion, speed, and direction.

Think about how unbalanced forces from people pulling the string will move the ball.
Forces make things move or make things change their motion. More than one force can act on an object at a time. What happens to the object when the forces act depends on how strong the forces are and the direction of the forces. The ball will move depending on the force each person places on the string.

The International Space Station (ISS) is a microgravity laboratory in which an international crew of six people live and work while traveling at a speed of five miles per second, orbiting Earth every 90 minutes, at 249 miles above the surface. Astronauts enter the International Space Station using docking ports.
MATERIALS:

- Computers
- Headphones
- Internet

INSTRUCTIONS:

Students learn how to program their own version of Flappy Birds using drag and drop programming. This activity includes a video introduction and then leads participants through 10 puzzles with increasing difficulty. If unable to play the video, there is a notes version on the website. This station takes about 10 – 15 minutes. It is recommended that teachers complete the challenge ahead of time.

1. Make sure you can access the following site: [https://studio.code.org/flappy/1](https://studio.code.org/flappy/1)
2. Set-up 5 – 10 computers to the site.
3. As students complete the activity, re-load the website.
4. Support struggling students.

STEM CAREER CONNECTION

A computer programmer creates the code for software applications and operating systems. After a software developer or computer software engineer designs a computer program, the programmer writes code that converts that design into a set of instructions a computer can follow. Programmers develop code on everything from iPhone apps, video games, industrial robots that build cars, and so much more.
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**Computer Animation**

Want more? Check out these sites:
- www.scratch.mit.edu
- www.code.org
- www.stencyl.com

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MATERIALS:

- Butcher paper
- Tape
- Markers

INSTRUCTIONS:

1. Select a theme for the STEM Mural that fits the evening’s activities. Examples include:
   - Space
   - Engineering
   - Chemistry
   - Earth
   - Inventions

2. Hang up large sheets of butcher paper in a central location

3. Provide bins of markers

4. Allow participants to draw and write something related to the theme

5. Display in the school after the event