Before you begin the activity, please hand out the pre-test to each student. The pre-test has two different grade levels, make sure to use the correct one for your age group. The pre-test will help us evaluate how effective this unit is on teaching kids about the engineering method. At the end of the quarter the same test will be administered again to see how much knowledge students have gained.
**Pre/Post Test for Unit 1: Engineer Design-It**

**Kinder-1st Grade**

Draw and/or write about the 6 steps in the engineering process and put them in the correct order.

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Unit 1: Engineer Design It

Next Generation Science Standards (NGSS):

K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

WEEK 1
Airplane that Hits a Target

K-1
20-30 Minutes

Supporting Materials & Prep:
Print copies of Folding Airplane Handout (next page)

Objective(s):
Design a paper airplane that can fly and hit a target.

Instructor Notes:

Materials:
- Process Grid
- Copy Paper
- Plans for folding an airplane
- Masking Tape
- Copies of Folding Airplane Handout

Setting the Stage:

Talk to students about the new unit. Tell them that they will be designing and redesigning lots of different contraptions. The idea is to make a plan, try it, think about how to improve it (redesign it) and try again.

Explain the objective for the lesson: they will make a paper airplane that will hit a target by standing 15 feet away.

Show the students some different ways to fold a paper airplane. They don’t have to use one of the ways that you show them, but this will get them started.

Activity Instructions:

1. Put up a circle target on one wall (draw one on a piece of paper if you don’t a pre-made one) and place a piece of tape 15 feet away from the target.

2. After students have designed their first airplane, have them go to the line and throw it. If it hits the target, can they stand farther away and still hit target? If they didn’t hit the target, ask them what they might change to make their plane hit the target. Have them try out their ideas.

3. At the end of the lesson, have them reflect on the airplanes. Which airplanes were able to hit the target? What do they notice about those planes? If their plane didn’t hit the target, what was the problem? How could they fix that problem? What seems to be the overall best design?
Method 1:

1. DIG. 1

Firstly fold the sheet in half along the line shown in DIG. 1 and then open it out again.

1. DIG. 2

Fold the two top corners in to the center line to give the form in DIG. 2

• DIG. 3

Then fold the top large triangle over so that the two flaps formed in step 2 are underneath the large triangle. Your paper should now look like DIG. 3
From the form in DIG. 3 fold the two top corners into the center line again in such a way that you get the form in DIG. 4

Now fold the small triangle up over the two flaps to give DIG. 5

Fold along the center line so that the small triangle is on the underside of the plane on the outside along with the two flaps as shown in DIG. 6

Fold along the line AB on DIG. 6 then turn the plane over and do the same to the other side producing DIG. 7.
Folding a Paper Airplane

Method 2:

1. **DIG. 1**

   Fold along the dotted line down the center of DIG. 1 then open the paper out and fold along the diagonal lines at the top to give DIG. 2.

2. **DIG. 2**

   Fold along the diagonal lines in DIG. 2 bringing the top left and top right edges in to meet along the center line as shown in DIG. 3.

3. **DIG. 3**

   Fold along the horizontal dotted line in DIG. 3 bringing the tip of the paper airplane down to the center of the base of the paper as shown in DIG. 4.
Folding a Paper Airplane

• DIG. 4

Now fold along the diagonal dotted lines in DIG. 4 to bring the left top edge and right top edge in to meet at the center line as shown in DIG. 5

1. DIG. 5

Now fold the flap that points downwards up so that its tip touches the tip of the paper airplane at the front. Fold along the dotted line shown in DIG. 5 to do this. If the tips do not meet go back and alter the folding so that they do. This is very important. You should get the form (approximately) in DIG. 6

• DIG. 6

Now finally fold along the center line and dotted lines in DIG. 6 to give you the paper airplane as shown at the top of the page. Throw it hard overarm and it should fly very level and very straight for a long distance.
Unit 1: Engineer Design It

K-1

Keep-a-Cube

WEEK 2

Next Generation Science Standards (NGSS):

K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

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Materials:
- Shoe Box  - Waxed Paper
- Masking Tape  - Newspaper
- Aluminum Foil  - Rubber Bands
- Ice Cubes  - Process Grids

Setting the Stage:

Ask students if they think they could keep an ice cube from melting. What are some ideas?

Explain the objective of the day: Students will make a contraption that will keep an ice cube from melting as fast as the ice cube that you will set out in front of the students. (This will be your control.)

Brainstorm some methods for building a shelter, and record on their Process Grids.

Objective(s):

Students will build a contraption that will keep their ice cube from melting as fast as a control ice cube sitting out in the classroom.

Instructor Notes:

Activity Instructions:

1. Have students work in groups of 3 or 4 to design their contraption. Have them place their ice cube inside. They will want to build fast so that their ice cube doesn’t continue melting!

2. After they build their contraptions, have them set their ice cubes inside and set them aside for 10-15 minutes. During that 10-15 minutes, ask each group to share how they made their contraption. What materials did they use? Why?

3. After you are done discussing, have students check their ice cube and compare it to the ice cube that was sitting out.

4. Discuss results. Which ice cube melted less? Which melted the most? What would they do next time?
Next Generation Science Standards (NGSS):
K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Materials:
- Pencil & Paper for writing a message
- Stuff to build a message delivery system: string, scissors, straws, water bottles, masking tape, rubber bands, etc.
- Process Grid

Setting the Stage:
Ask students: When you’re stranded on a deserted island, you can’t use a telephone or e-mail to communicate to others across the island. So how would you get a message to a friend on the other side of your island?

Explain the objective of the day: students will build a way to deliver a message from one side of the table (island) to the other. (Without throwing it or using their own feet to deliver it!)

Brainstorm ideas of what a delivery system might look like. Have them add their ideas to their Process Grid.

Activity Instructions:
1. Have students in teams of three. Each team can write a secret message to another team.
2. After they write their message, have them begin working on their delivery system. As they work, ask them questions about their plan. If something doesn’t work, ask them what they could do to redesign it. You may have to give a few suggestions to get them started. It could be as simple as rolling the message in a bottle across the table or folding it into an airplane to fly through the air, or a catapult. (Don’t give any hints unless there are some students really struggling and frustrated.)
3. If students succeed quickly, place “obstacles” in the way for more of a challenge.
4. At the end of the lesson, discuss what worked and what didn’t work. Add their results and what they learned to their Process Grid.
**Unit 1: Engineer Design It**

**Next Generation Science Standards (NGSS):**

- **K-2-ETS1-1:** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- **K-2-ETS1-2:** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
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- **3-5-ETS1-3:** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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**K-5**

**Prep:** None

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<tr>
<td>- Aluminum foil (1 sq. foot for each pair of students, extra foil to redesign</td>
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<td>- 100 pennies</td>
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<tr>
<td>- Bucket or tub of water</td>
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<td>- Process Grid</td>
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**Setting the Stage:**

**Ask** students to think about different boats that they have seen. What shape did they have? What were they made out of?

**Explain** objective for the day: students will design a boat and test the number of pennies it can hold before it sinks.

**Brainstorm** ideas for building a boat, and have students add their ideas to their Process Grid.

**Objective(s):**

Students will construct a boat out of aluminum foil that can hold the most pennies.

**Instructor Notes:**

**Activity Instructions:**

1. Give students each one square foot sheet of aluminum foil. They can cut it, fold it, staple it, do whatever they want to design their boat.

2. When students have built their boat, let them test it and see how many pennies they can place in it without it sinking. Have them record their results on their Process Grid. When they know how many pennies their boat can hold, have them go back and redesign their boat to make it hold more pennies.

3. Re-test boats, and record the new results.

4. As a whole group, reflect on the results. How many pennies could the boat hold? How did they re-design their boat? Did the re-design work? Why or why not? Have students add what they learned to their Process Grids.
BUOYANCY

WEEK 5
Sink the Ship

Next Generation Science Standards (NGSS):

K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Materials:
- Process Grid
- 1/2 Stick of clay per small group
- Bucket or large bowl of water
- Small rocks or pebbles
- Straws

Setting the Stage:

Ask students what kinds of things float on water and what kinds of things sink. What did they learn last week about what makes a boat float?

Explain today’s objective: Students will make a boat out of clay that can float. Then they need to figure out how to make it sink.

Brainstorm ideas for how they can design their boats. What will make it float? What will make it sink? Have them record their ideas (sketches) on their Process Grid.

Objective(s):
Students will design a boat that floats and then find a way to make their boat sink to the bottom.

Instructor Notes:

Activity Instructions:

1. In groups of 3-4, have students design their boats using the clay. As they design, ask them questions about how they are deciding what to build.

2. Fill the bucket with water. Once students have designed their floating boats, have them test them to make sure they float.

3. Once they prove their boat can float, have them modify the design or add things to their boat to make it sink. They can add the small rocks or straws, or anything else you have on hand.

4. Have them re-test their boats to prove they can sink. Add results to their Process Grid.

5. As a whole group, discuss their designs. What did they do to make the boat sink? Can they think of any reason why someone would want to sink a boat? (You can tell them that when boats get too old to use anymore, the navy will sink them on purpose so that plants and animals can live and grow on it. It is called an artificial reef).
## Unit 1: Engineer Design It

**Next Generation Science Standards (NGSS):**

K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

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**WEEK 6**

**Ball from Here to There**

### Materials:

- 1 Small Bouncy Ball
- 5 Sheets of Paper
- 10 Paper Clips
- 5 Rubber Bands
- 2 Tables of Desks
- String
- Masking Tape
- 1 Ruler
- Process Grid

### Setting the Stage:

**Ask** students: What are some ways we get from one side of a river to the other? (Bridges, boats, airplane, etc).

**Explain** today’s objective: Create a way (without using your hands to throw it) to get a ball from one table to another.

**Brainstorm** ideas and have students add their ideas (sketches if they can’t write) to their Process Grids.

### Activity Instructions:

1. Divide students into groups of 3-4, and set each group up with two desks 3 feet apart. Give them their materials, and let them start designing and testing their models.

2. As they design, go around and ask students what is working and what isn’t working. If students succeed quickly, increase the distance between the desks and have them design again.

3. At the end of the class, discuss results as a whole group. Have groups share what they did, and explain what different designs they tried. What worked the best? What didn’t work? Record their results on their Process Grids.
## Unit 1: Engineer Design It

### Next Generation Science Standards (NGSS):

- **K-2-ETS1-1:** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- **K-2-ETS1-2:** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

### Setting the Stage:

**Give** students a toilet paper tube and a straw.

**Ask** them if they can make it roll from one side of the table to the other.

**Explain** today’s objective: To make a paper tube that can roll faster than the toilet paper tube.

**Show** students the materials and have students share their ideas for how to make their own paper tube that rolls faster. (Bigger, smaller, longer, shorter.) Have them add their ideas to their Process Grid (sketches if they can’t write).

### Objective(s):

Students will make a paper tube that rolls the fastest powered by the students blowing on it through a straw.

### Instructor Notes:

- Activity Instructions:
  1. Hand out materials and let students experiment to make their own tubes. When students get their tube made, have them have a race with a partner. (One blows on student made tube and the other blows on toilet paper tube.)
  2. Ask them if they can change their design and make it go even faster. Have them record their results on their Process Grid.
  3. When everyone has a “fast” tube, let them have a “roll off” against each other.
  4. At the end of the lesson, discuss which tube went the fastest and why they think it did. Which wasn’t as fast? Why not? Add what they learned to their Process Grid.
## TOWERS

### WEEK 8

**Marshmallow Tower**

### Next Generation Science Standards (NGSS):

- **K-2-ETS1-1:** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

- **K-2-ETS1-2:** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

### K-1

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### Materials:
- Process Grid
- 2 Bags of large Marshmallows for each group

### Setting the Stage:

**Ask** students if they have ever seen a really high tower. What did it look like? What did the base look like? What kept it strong?

**Explain** today's objective: Students will build the tallest tower they can with marshmallows.

**Brainstorm** ideas of how they might build the base of their tower to make it strong. Have them add their ideas to their Process Chart (sketches if they can't draw).

### Objective(s):

Students will build a tower as high as possible without it falling down.

### Instructor Notes:

### Activity Instructions:

1. In groups of 3-4, let students to begin building their towers. If their tower falls down, ask them how they could change the base to make it stronger. Have them record their results on their Process Grid.

2. If they manage to use up all their marshmallows and their tower is still standing, ask them if they could use the same number of marshmallows, but make a taller tower. How could they change their design to do that?

3. When done, use the idea that worked best and try it using all of the marshmallows to build the very biggest tower possible.

4. At the end of the class, discuss what worked and what didn’t. What did the tallest tower look like? Add what they learned to their Process Grid.
**BRIDGES**

**WEEK 9**

*Paper Bridge*

### Next Generation Science Standards (NGSS):

**K-2-ETS1-1:** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

**K-2-ETS1-2:** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

### K-1

**30 Minutes**

**Prep:** None

**Materials:**
- 50 Pennies
- Process Grid
- Per Group:
  - 3 Pieces of Copy Paper
  - 6 Books (same size)
  - Tape

### Setting the Stage:

**Ask** students if they think they can make a bridge that holds 50 pennies with just one piece of paper. What have they learned about making strong structures?

**Explain** today’s objective: To make a bridge between the 2 stacks of books that holds 50 pennies.

**Ask** them what they might do to the paper to make a bridge? (Cut it, fold it, etc.) Have them share their ideas and add to their Process Grids (sketch if they can’t write).

### Objective(s):**

Students will make a bridge in between two stacks of books that are 6 inches apart by using 1 piece of paper that supports 50 pennies.

### Instructor Notes:

### Activity Instructions:

1. Have students work in groups to build their bridges. Remind them they can only use one sheet of paper! (Give them 3 sheets so that they can re-design).

2. Have them test their bridges with the pennies. If their first idea doesn’t work, ask them how they can change their paper to make it stronger. If their design works, ask them to make a bridge that is 8 or 10 inches long. Have them record their results on their Process Grid.

3. At the end of the lesson, discuss the results. What worked and what didn’t work? How did they re-design their bridges? Record what they learned on their Process Grid.
ASC STEM Reflection for Unit 1: Engineer Design-It

Grade Level: _____

1. Did you use the process grid consistently?  Yes/No

2. Did you state the objective daily?  Yes/No

3. Could students tell you what they were learning?  Yes/No

4. Were students engaged in the lessons?  Yes/No
   If not, which lessons? ______________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________

5. Were the lessons inquiry based? (Teacher led lesson by questions, not by giving students the answers.)  Yes/No

6. Did you feel comfortable using questions to guide the students’ self-discoveries?  Yes/No

7. Did you feel comfortable leading the reflection piece of the lesson?  Yes/No

8. Does teacher feel comfortable teaching this unit?  Yes/No
   Why or why not?
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________

Suggestions for the next training?
   _______________________________________________________________________
   _______________________________________________________________________
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K-1

UNIT 2 | INVISIBLE FORCES
Before you begin the activity, please hand out the pre-test to each student. The pre-test has two different grade levels, make sure to use the correct one for your age group. The pre-test will help us evaluate how effective this unit is on teaching kids about the engineering method. At the end of the quarter the same test will be administered again to see how much knowledge students have gained.
## Pre/Post Test for Unit 2: Invisible Forces

**Kinder-1st Grade**

Draw and/or write about the 6 steps in the engineering process and put them in the correct order.

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Materials List
Unit 2
K-1
1. **Wire**
   - Bell wire (20 gauge)
   - or aluminum foil strips, backed or covered with masking tape

2. **Bulb**
   - Flashlight bulbs
   - or miniature Christmas lights (replace bulb and holder)
   - cut lights apart

3. **Bulb Holder**
   - or foil strip clamped next to the side of the bulb
   - or tape wire to side of bulb

4. **Switch**
   - 2 brace paper fasteners
   - 1 piece of tagboard
   - 1 large paper clip
**STATICALLY CHARGED OBJECTS**

**WEEK 1**

**Statically Charged Objects**

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**Unit 2: Invisible Forces**

Next Generation Science Standards (NGSS):

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

---

**K-5**

**20-30 Minutes**

**Prep & Supporting Materials:**

Pre Tests (K-5)

Investigation Worksheet: Statically Charged Objects (K-5)

---

**Materials:**

- Class set of Investigation Worksheet for testing the objects.
- Per Student or Pair:
  - 1 8x11" piece of Plastic Wrap
  - 1 sheet of Paper Towel
  - 2 Paper Clips
  - 1 piece of Thread
  - 1 Piece of String
  - 1 Pinch of Salt
  - 1 small piece of Styrofoam Cup
  - 1 small piece of Aluminum Foil
  - 1 Pencil

---

**Setting the Stage:**

*Explain* to students about the new unit “Invisible Forces”. Tell them that they will be experimenting with forces that we can’t see. They will be using static electricity (Have you ever seen someone hair standing up due to something in the air?) and magnets.

*Ask* students: Have you ever zapped /shocked someone on accident? Have you ever used this kind of plastic wrap? Have you noticed how things magically stick to it? Does everything stick to it? This invisible force that makes things stick to the plastic wrap is called “static electricity”. We’re going to experiment with “static electricity” today!

*Show* students how to “statically charge” their plastic wrap. Lay the plastic wrap flat on the table. Rub it with a paper towel. Students can then lift the plastic wrap from the desk by one corner and observe what happens. Then have them charge it again (by rubbing it with the paper towel) and pick up by the midpoints of two opposite sides. What happens? Explain that this is "static electricity" that is causing it to do what they observed.

*Explain* the objective of the day. They will be testing different objects to see which objects are affected by the statically charged plastic wrap and which objects aren’t.

*Demonstrate* with the first object how to use the student worksheet to keep track of their data. They can use backside of worksheet to write in objects that they want to investigate.

*Brainstorm* what they think will happen with a partner. Have students add their ideas to their Process Grid.

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**Objective(s):**

Which objects does the statically charged plastic wrap affect? Why?

**Instructor Notes:**

---

**Activity Instructions:**

1. Students investigate the different objects. Ask questions to help students think about why some objects are affected by statically charged plastic wrap and why others aren’t.
2. Have students reflect in whole group about the objects that were and weren’t affected and their conclusions. (The static charge can affect light objects, but not heavy objects.) Have them add their conclusions to Process Grid.
# Investigation Worksheet: Statically Charged Objects

<table>
<thead>
<tr>
<th>Object</th>
<th>Affects</th>
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<tr>
<td>Thread</td>
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<td>Paper clips</td>
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<td>Pencil</td>
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</table>
Unit 2: Invisible Forces

Next Generation Science Standards (NGSS):

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Materials:
- Class set of Investigation Worksheet for testing the objects.
- 1 Balloon (inflated prior to lesson)
- 1 piece of Thread - 1 piece of String - 1 pinch of Salt
- 1 Pencil - 2 Paper Clips - 1 piece of Styrofoam Cup
- 1 small square of Aluminum Foil
- Optional: Nylon, Plastic Wrap, Paper Towel, etc.

Setting the Stage:
Ask students if they’ve ever rubbed a balloon against their head. What happened?
Show students how to “statically charge” their balloon by rubbing it against their hair. They’ll know it’s charged when their hair begins to stick up! (Or use nylon to rub against the balloon.)
Explain the objective of the day. They will be testing different objects to see which are affected by the statically charged balloon and which objects aren’t.
Demonstrate with the first object how to use the student worksheet to keep track of their data. They can use backside of worksheet to write in objects that they want to investigate.
Brainstorm what will happen. Have them add their ideas to their Process Grid.

Objective(s):
Test different objects to determine which are affected by the statically charged balloon and which objects aren’t.

Activity Instructions:
1. Students investigate the different objects. Ask questions to help students think about why some objects are affected by the statically charged balloon and why others aren’t. Have them record their observations on the worksheet.

2. Have students reflect in whole group about the objects that were and weren’t affected and their conclusions. (The static charge can affect light objects, but not heavy objects.) Have students add their conclusions to their Process Grid.

3. Challenge: What happens if they touch the statically charged plastic wrap from last week to the statically charged balloon? Make predictions and try it out!
## Investigation Worksheet: Statically Charged Balloons

Name: __________________________________________

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<th>Object</th>
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MAGNETIC ATTRACTION

WEEK 3
Magnetic Attraction

Unit 2: Invisible Forces

Next Generation Science Standards (NGSS):

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Supporting Materials:
Investigation Worksheet: Magnetic Attraction (K-1)

Materials: Per Group
- 1 Magnet
- 1 Rubber Band
- 1 4x4" piece of Aluminum Foil
- 1 Paper Clip
- 1 Nail
- 1 Pencil
- 1 Penny
- 1 piece of Thread
- 1 piece of Styrofoam Cup

Objective (s):
Test different object to see which objects are attracted to the magnet and which objects aren’t.

Instructor Notes:

Setting the Stage:
Review the “invisible forces” (static electricity) from last week. Tell them that they will be experimenting with a different invisible force today, a magnetic force.

Ask the students what they can name that is attracted to a magnet?

Explain the objective of the day. They will be testing different objects to see which objects are attracted to the magnet and which objects aren’t.

Demonstrate with the first object how to use the student worksheet to keep track of their data. They can use backside of worksheet to write in objects that they want to investigate.

Brainstorm with a partner which objects will be attracted to the magnet. Have them add their ideas to their Process Grid.

Activity Instructions:
1. Students investigate the different objects, testing to see if they are attracted to the magnet. Ask questions to help students think about why some objects are attracted to the magnet and why others aren’t.

2. Have students reflect in whole group about the objects that were and weren’t attracted and their conclusions. (Metal, not metal) Have them add their ideas to their Process Grid.
### Investigation Worksheet: Magnetic Attraction

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<td>Penny</td>
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<td>Scissors</td>
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MAGNETIC FORCE

WEEK 4
Magnetic Force

Unit 2: Invisible Forces

Next Generation Science Standards (NGSS):

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Objective (s):
Test different objects to see if the magnetic force is strong enough to pass through and attract a paper clip.

Prep:
None

Materials: Per Group:
- 1 Magnet
- Cardboard
- Tin Can
- Shoe
- Challenge: Phone Book
- 1 Paper Clip
- Plastic Cup of Water
- 8 1/2x11" piece of Aluminum Foil
- 1 Wooden Ruler
- Piece of Fabric (use Nylon from wk2)
- Book

Activity Instructions:

1. Have students investigate the different objects and record their observations on their Process Grid. Ask questions to help students think about why the magnetic force can pass through some objects and why it can’t pass through others.

2. Let students reflect in a whole group about the objects that the magnetic force could pass through and the objects that it couldn’t pass through. Have them make a conclusion, and add their conclusions to their Process Grid.

3. Challenge: Use a phone book – see how many pages the force will pass through before it is too weak!

Setting the Stage:

Ask students if they think that the magnetic force can be strong enough to pass through other objects. Show them how the force of the magnet can still pull on the paperclip through a piece of paper. What other objects do they think the magnetic force will pass through? What won’t it pass through?

Explain the objective of the day. They will be testing different objects to see if the magnetic force is strong enough to pass through and attract a paperclip.

Brainstorm with a partner which objects will let the magnetic force pass through them. Have them add their ideas to their Process Grid.
K-1

MAGNETIC STRENGTH

WEEK 5
Magnetic Strength

Unit 2: Invisible Forces

Next Generation Science Standards (NGSS):

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Materials:
- 2 different kinds of Magnets
- 50-100 Paper Clips per group

Setting the Stage:

Ask them to predict how many paperclips their magnet can hold?

Explain the objective of the day. They will be connecting paperclips, one at a time to test the strength of their magnet. They will be testing both magnets to see which can hold more. Then they will try to make their magnetic force stronger.

Brainstorm ideas with a partner. Add their ideas to their Process Grid.

Objective (s):
Connect paper clips, one at a time to test the strength of their magnet. They will be testing both magnets to see which can hold more, and then try to make their magnetic force stronger.

Instructor Notes:

Activity Instructions:

1. Have students do the investigation and determine how many paperclips their magnet can hold. Record their results on their Process Grid. As they find the number of paperclips that their magnet can hold, ask them if there is any way to make it hold more. Let them experiment with which part of the magnet is stronger, what happens if they put 2 magnets together, etc. (Don’t lead them, but let them experiment with the possibilities.)

2. Have kids draw what does/doesn’t work (optional).

3. Discuss results, and have students add their results to their Process Grid.
Next Generation Science Standards (NGSS):

3-PS2-3: Ask questions to determine cause and affect relationships of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Objective(s):

How can you make an object move using a magnet? How many hounds can you get to move down the path to find their bones at one time?

Instructor Notes:

Activity Instructions:

1. Give students their materials and see what they can do! (After they get one dog to move down the path, have them come up with how they could get 2 dogs to move down the path at the same time. Then 3...etc.) (Record on chart.)

2. Discuss what worked and what didn’t work with group. (Record on chart.)
**Unit 2: Invisible Forces**

**Next Generation Science Standards (NGSS):**

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

---

**K-1**

**30 Minutes**

**Prep:** None

**Materials:**

- Paper Clips
- Metal Bolt
- Pencil
- Scissors
- Small Container of separated staples, magnetic bars

**Setting the Stage:**

**Explain** today's objective. They are going to test which of the following objects will make the strongest magnet (paperclip, bolt, pencil, pair of scissors). They will test their magnetic force by testing which magnet will pick up the most staples.

**Show** students how each of the objects can’t pick up staples at the beginning of the investigation.

**Ask** students to predict which will make the best magnet and why. (Record on chart.)

**Show** students how to make a magnet by demonstrating with the paperclip. Rub the paperclip on the magnetic bar quickly for about 50 strokes. The paperclip should now be magnetized, and able to pick up one of the staples.

**Objective(s):**

Which makes the best magnet? Prove it!

**Instructor Notes:**

---

**Activity Instructions:**

1. Give students their materials and let them try to magnetize their objects. They can try stroking on one direction only, or back and forth to see if this makes a difference as well.

2. Discuss results as a whole class. Which objects made the best magnet?
Defying Gravity

Unit 2: Invisible Forces

Next Generation Science Standards (NGSS):

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

<table>
<thead>
<tr>
<th>K-1</th>
<th>Prep: None</th>
<th>Objective (s): Can you make an object defy gravity?!</th>
</tr>
</thead>
</table>

Materials:
- Magnets
- Paper Clips
- String
- Tape
- Steel Soup Can (unopened)

Setting the Stage:

Explain today’s objective.

Talk about what gravity is. Use a paperclip with a string attached. Tape one end of the string to the table. What happens if you pick up the paperclip and then drop it? Where does it go? So...if we were trying to defy gravity, what would it do? (stay in the air)

Brainstorm ideas and add them to their Process Grid.

Activity Instructions:

1. Give them their materials and observe. (Don’t give any hints until almost the end!)

2. If anyone figures it out early on, give them other challenges. (How far can they move the soup can before it doesn’t work anymore? How many paperclips can they attach together?)

3. Discuss as a whole group what worked and why they think it worked.
Unit 2: Invisible Forces

Next Generation Science Standards (NGSS):

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Setting the Stage:

Discuss today’s objective. This is like a relay, but against their own team. Each team will use the balloon and the magnet to move the objects to the other side of the room. Teacher will time groups the first time through. Then, groups will discuss how they can get the objects down faster. (You can determine the number of students in a group, but they should be as equal as possible.)

Objective(s):

How can your team get these objects to another location faster than the first time?

Instructor Notes:

Activity Instructions:

1. Rules:
   a. You can’t use the balloon and the magnet on a single trip to the other side.
   b. You can’t use your hands to touch the object that is being transported to the other side.
   c. Each member of the team has to take a trip down to the other side.

2. Discuss the strategies that the students used. What worked and what didn’t work?
Before you begin the activity, please hand out the **pre-test** to each student. The pre-test has two different grade levels, make sure to use the correct one for your age group. The pre-test will help us evaluate how effective this unit is on teaching kids about the engineering method. At the end of the quarter the same test will be administered again to see how much knowledge students have gained.
Pre/Post Test for Unit 3: Mechanical Engineering

Kinder-1st Grade

Draw and/or write about the 6 steps in the engineering process and put them in the correct order.

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<tr>
<th>1.</th>
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<th>3.</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Create a Model" /></td>
<td><img src="image2.png" alt="Improve Your Model and Retest" /></td>
<td><img src="image3.png" alt="Brainstorm Ideas" /></td>
</tr>
<tr>
<td><img src="image4.png" alt="Explained what You Learned" /></td>
<td><img src="image5.png" alt="Test Your Model" /></td>
<td><img src="image6.png" alt="Think of a Problem" /></td>
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<tr>
<td>Process Grid:</td>
<td>Explain what You did and learned</td>
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<td>-------------</td>
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<tr>
<td>Improve Your Model &amp; Retest</td>
<td>Explain Justify</td>
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<tr>
<td>Test Your Model</td>
<td>Modifications Operational Optimization</td>
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<tr>
<td>Create a Model</td>
<td>Failure Data Testing Instrumentation</td>
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</tr>
<tr>
<td>Brainstorm Ideas &amp; Solutions</td>
<td>Assembly Component Design Model Prototype System Technology</td>
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<tr>
<td>What is the Problem?</td>
<td>Problem Constraints Criteria</td>
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INTROS & TOPS

WEEK 1
Tops Engineering

Unit 3: Mechanical Engineering

Next Generation Science Standards (NGSS):

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-5
30 Minutes

Prep & Supporting Materials:
Pre & Post Tests (K-5)

Materials:
- Process Grid  - Clay  - Pencils
- Small Paper Plates  - Paper Clips  - Stop Watches

Setting the Stage:

Ask students: “What do you know about mechanical engineering?” Write their ideas, and show them pictures of vehicles, machines, etc., and have them guess what they have in common. Mechanical engineering involves making something that has motion—deals with tools and machinery.

Explain the objective of the day. Show them different tops to start the thinking process.

Objective (s):
Design a top that spins the longest.

Instructor Notes:

Activity Instructions:

1. Show the students the materials. Don't give them any details on how to design their top. Have them brainstorm with a partner what they might do. Add some of their ideas to the process grid. (K-1 – You can tell them that they need to poke the pencil through the plate to make it spin, but don’t tell them where to poke the pencil. Let them experiment with putting the pencil in different places and talking about balance with them.)
3. When students are ready, have them go to the “testing area” and time how long their top spins. Record results on sticky notes. Have them go back and redesign to make it spin longer.
4. Have them reflect on the tops. What made them spin best? What could they change next week? Does the surface that they are spinning on matter? How could they make changes to the surface?
5. Keep their tops and results for the following week.
6. For Week 2, challenge them to use pennies to balance their tops. How does it change the spinning of the top?
Next Generation Science Standards (NGSS):

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

**Setting the Stage:**

Ask students: "What do you know about mechanical engineering?" Write their ideas, and show them pictures of vehicles, machines, etc., and have them guess what they have in common. Mechanical engineering involves making something that has motion - deals with tools and machinery.

**Explain** the objective of the day. Show them different tops to start the thinking process.

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Next Generation Science Standards (NGSS):

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Objectives:

Students will create a catapult out of materials provided that will fling a marshmallow over the wall. (Use your supply tub as the wall, if needed).

Materials:

- 15 Newspaper Sections
- 15 Plastic Spoons
- Marshmallows
- Masking Tape
- Rubber Bands

Setting the Stage:

Ask the students: “Have you ever seen a catapult? What do they do? What is their purpose? How do you think they do this?”

Explain the objective of the day.

Brainstorm which ideas they might want to try first. Where might they attach the spoon to their base? Have them brainstorm and fill their ideas in on the Process Grid.

Activity Instructions:

1. Have students work in pairs or groups of 3 to create their device. Remember to NOT tell them HOW to design it! (Teacher adds to Process Grid what students are attempting under the ‘Create a Model’ section.)

2. When students have designed their catapult, have them test it to see if their marshmallow goes over the wall. (Maybe have 2 groups testing at a time.) Teacher adds a couple of results to Process Grid. EX: 1 catapult fell over and didn’t work. 1 catapult projected the marshmallow straight up.

3. Have them reflect on their catapult and make changes. Then retest.

4. Reflect on what worked the best and why it worked.
How to build a mini-catapult:

1. Roll newspaper section like a log.
2. Secure the log with tape.
3. Stretch a rubber band, place log on top of it.
4. Loop the two ends of the rubber band to the top of the log. Pass one end of the rubber band through the other. Hold the surplus with your finger.
5. Stick the end of spoon through surplus rubber band.
6. Adjust spoon length and tape log down. Test catapult.
**Unit 3: Mechanical Engineering**

**Next Generation Science Standards (NGSS):**

- K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

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<table>
<thead>
<tr>
<th>K-5</th>
<th>30 Minutes</th>
<th>Prep &amp; Supporting Materials: None</th>
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**Materials:**
- Normal craft sticks (popsicle sticks)
- Masking Tape
- Wooden Clothespins
- Marshmallows
- Ruler to measure distance
- Plastic Spoons
- Rubber Bands
- Use same Bases from week 1

**Setting the Stage:**

- **Review** catapults from last week. Which catapults worked? Which ones didn’t? Why?

- **Explain** the objective of the day.

- **Ask** students: What did we learn that would help us improve our design this week? What will happen if we change the position of the throwing arm? What will happen if we change the length of the throwing arm? (Show them how to attach the spoon to a popsicle stick to make it longer.)

**Objective(s):**

Students will create a catapult that will fling a marshmallow the furthest.

**Instructor Notes:**

**Activity Instructions:**

1. Students work on their device in their partners or group of 3. If they come across a design ‘flaw’ or problem, DON’T tell them how to fix it. Instead, ask “How could you make it go farther instead of higher this time?”

2. When students have re-designed their catapult, have them test it and mark the distance with a sticky note. Have a line designated as the starting line. Only let 2-3 groups test at a time. (Teacher adds a couple of results to Process Grid.)

3. Have them reflect on their catapult and the changes that they made to it. Have a couple of students share changes they made to overcome a problem, or what seemed to work to make their catapult fling the marshmallow furthest. (Note down their responses on the Process Grid under ‘Explain What You Did and Learned’).
CARS & RAMPS

WEEK 6

Cars & Ramps

K-5

Prep: None

K-1

Materials:
- Cardboard squares cut to about 7x4” (1 per student)
- Wooden Dowels cut to 6” long (2 per student)
- 2 Straws about 4” long (2 per student)
- Cereal Boxes or Cardboard cut into circles with a 3” diameter (4 per student)

Setting the Stage:

Ask students: How does a vehicle move? How do you make it go straight? How do you make it go far? Where does the car get its energy? (Mention axles, wheels, force to make it go; today it’s the ramp)

Explain the objective of the day.

Show students a model car and have them brainstorm how they might design their own.

Objective (s):

Students will design a car that will roll straight and far down a ramp.

Instructor Notes:

Activity Instructions:

1. Give students materials to design their own car. Show K-1 the steps to make the car, but let 2-5 design it themselves. (K-1 will work on building their cars both this week and next).

2. When students are ready, have them test out their car using a ramp. Set up a ramp for testing with a line of masking tape coming straight out from the ramp. When students are ready, they test their car and mark where it stops with a sticky note. The car that stays closest to the line and the farthest out has the best design!

3. Reflect on the car and ramp height that worked the best. Discuss why they think that worked. (Writes on Process Grid.)

4. Keep cars for next week.

Next Generation Science Standards (NGSS):

K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

K-PS2-2: Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.
### Setting the Stage:

**Review** cars and ramps from previous week. What progress have they made? What do they still need to do?

### Objective(s):

Students will design a car that will roll straight and far down a ramp.

### Activity Instructions:

1. Same as last week. Complete last week's activity as well as improve upon design, etc.
### SELF-PROPELLED CARS
#### PART 2

#### WEEK 7
*Cars that Move with Sails*

### Setting the Stage:

**Review** with students which sails caught the most wind when they made the sails for the boats during the Wind Unit. Explain that they will be making their car move by capturing the power of the wind.

**Explain** the objective of the day.

**Write** down on Process Grid their ideas of what kind of sail they will make and where they will place it on their car base.

**Show** them that they will use a ball of clay to attach their sail to their car platform.

### Objective (s):

Students will create a car that will go the furthest using the power of the wind.

### Instructor Notes:

Activity Instructions:

1. Have students choose their materials and build their sails. When their sails are ready, have them attach them to their cars.

2. Have students bring their car to the fan site and test it. Mark how far it went with a sticky note. Then ask them questions about how they could make their sail better or move it so that it goes farther.

3. Reflect on which sail captured the wind the best and where it was placed. Discuss why they think that worked. (Write on Process Grid.)

4. Keep cars for next week.
## EGG-SAFE SEAT

### WEEK 8

*Cars that Safely Transport an Egg*

### Supporting Materials:

<table>
<thead>
<tr>
<th>K-5</th>
<th>30 Minutes</th>
<th>Supporting Materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cars from previous weeks</td>
</tr>
</tbody>
</table>

### Materials:

- Cars from previous weeks
- Tissue Paper
- Paper
- Any left over supplies from previous weeks
- Eggs
- String
- Clay
- Cotton Balls
- Tape
- Cups

### Setting the Stage:

**Explain** today's objective.

**Brainstorm** ideas for making a "seat" that will protect the egg and keep it from breaking when the car goes down a ramp and has contact with a wall (Add ideas to Process Grid.)

### Objective(s):

Students will create a car that can safely transport an egg when it comes in contact with a wall.

### Instructor Notes:

### Activity Instructions:

1. Have students design their "egg seat" with materials of their choice.

2. When ready to test, have students test their cars. Place a ramp close to the wall and let them test and redesign their egg seat. (You may want to use something other than a real egg for initial testing).

3. Reflect on different seat designs. Have students make predictions about which seat designs will best protect the eggs. Add predictions to Process Grid.

4. Keep cars for next week with seats.
**EGG-SAFE SEAT**

**WEEK 9**

*Testing Egg-Seats*

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**Supporting Materials:**
- Cars from previous weeks & Post Test

**Materials:**
- Cars from previous weeks
- Eggs

**Setting the Stage:**

**Explain** today’s objective.

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**Objective (s):**

Students test their egg safety seat by letting it go down a ramp and contact the wall.

**Instructor Notes:**

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**Activity Instructions:**

1. Test all cars. Teacher puts egg in ‘safe seat’ before letting car roll down the ramp.

2. Chart results on Process Grid. What worked well? If the egg cracked, what can they do to make it ‘safer’ or to better protect the egg?


4. Have students write/ draw a reflection on their favorite project from their unit on Mechanical Engineering, or what they learned from it when they’ve finished testing their ‘egg-safe seat’. If there’s time, they can share with another student

5. In the last 5 minutes, have students fill out Post-Test.

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**Next Generation Science Standards (NGSS):**

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
UNIT 4 | SOUND
Before you begin the activity, please hand out the pre-test to each student. The pre-test has two different grade levels, make sure to use the correct one for your age group. The pre-test will help us evaluate how effective this unit is on teaching kids about the engineering method. At the end of the quarter the same test will be administered again to see how much knowledge students have gained.
Pre/Post Test for Unit 3: Mechanical Engineering

Kinder-1st Grade

Draw and/or write about the 6 steps in the engineering process and put them in the correct order.

1. Create a Model
2. Improve Your Model and Retest
3. Brainstorm Ideas
4. Explained what You Learned
5. Test Your Model
6. Think of a Problem
<table>
<thead>
<tr>
<th>Process Grid:</th>
<th>What is the Problem?</th>
<th>Problem Constraints</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainstorm Ideas &amp; Solutions</td>
<td></td>
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<tr>
<td>Create a Model</td>
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<tr>
<td>Test Your Model</td>
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<td></td>
<td></td>
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<tr>
<td>Improve Your Model &amp; Retest</td>
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<td></td>
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<tr>
<td>Explain what You did and learned</td>
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<td>Explain Justify</td>
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<td>Modifications</td>
<td>Operational Optimization</td>
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<td>Failure</td>
<td>Data Testing Instrumentation</td>
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<td></td>
<td></td>
<td>Assembly</td>
<td>Component Design Model Prototype System Technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Innovation</td>
<td>Invention Solution Trade-Off</td>
</tr>
</tbody>
</table>
**INTRODUCTION TO SOUND**

**WEEK 1**

*Sound Contraptions*

**Unit 4: Sound**

**Next Generation Science Standards (NGSS):**

1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

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**Supporting Materials:**

- Pre and Post Tests
- Sound Vocabulary
- Sound Background Information

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**Materials:**

- Process Grid
- 2 Slinkys
- 4 Metal Hangers
- 4 Metal Spoons or Forks
- 4 Wooden Rulers
- Set of Tuning Forks
- Different sizes of Rubber Bands
- Small Plastic Cups
- String

* Instructor needs to create a sound contraption before class and keep in kit.

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**Objective(s):**

Students will be able to explain how sound is produced.

---

**Instructor Notes:**

- Get kids moving by asking them a question but involving movement. For example, “If you like apples, stand up.”

---

**Activity Instructions:**

- As students are exploring, ask them questions to extend their thinking on sound. Write on the process grid what you hear them saying. For example- Why do they sound different? What do you think caused___________? How___________?

- Have them reflect on the sound contraptions. What caused each of them to produce sound? (If the word ‘vibration’ doesn’t come up, this is the time to introduce it.) What else did they notice about the sound contraptions? (Pitch-High/Low sounds, volume-soft/loud)

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**Variations/ Alternatives**

1. 4/5 extension- can use a tuning fork and put in water to show ‘waves’. Different tuning forks should show different waves. Have them reflect on what the waves have to do with sound.
**Sound Vocabulary**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>Repetition of a sound by reflection of sound waves from a surface.</td>
</tr>
<tr>
<td>Frequency</td>
<td>The rate of vibrations in different pitches.</td>
</tr>
<tr>
<td>Pitch</td>
<td>The highness or lowness of a sound.</td>
</tr>
<tr>
<td>Sound Energy</td>
<td>Audible energy that is released when you talk, play musical instruments or</td>
</tr>
<tr>
<td></td>
<td>slam a door.</td>
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<tr>
<td>Vibration</td>
<td>When something moves back and forth, it is said to vibrate. Sound is</td>
</tr>
<tr>
<td></td>
<td>made by vibrations that are usually too fast to see.</td>
</tr>
<tr>
<td>Volume</td>
<td>When sound becomes softer or louder</td>
</tr>
<tr>
<td>Wave</td>
<td>A disturbance that travels through a medium, such as air or water.</td>
</tr>
</tbody>
</table>
Invite children to close their eyes and listen. What do they hear? How do they hear it? In this unit, they will explore sound, a kind of energy we can hear. Remind children that light and heat are other types of energy that are important to our daily lives. Sound is made when something vibrates and pushes molecules in the air to create waves. The waves travel to our ears and vibrate our eardrums, which helps us hear. Unlike light, sound waves require a medium (matter) to travel through, and they can move through solids, liquids, and gases. Sound travels faster through solids than through liquids, and more slowly still through gases. Sounds can differ in volume or pitch and can also be absorbed or blocked by objects. An echo occurs when a sound bounces off of something and returns to its source. Remind children that sound travels slower than light, which is why they’ll usually see a flash of lightening before they hear the crack of thunder; both happen at the same time, but light reaches us before the sound does. We recommend doing plenty of hands-on activities and experiments with children to help them explore, understand, and have fun with sound.

Have children place their hands on the sides of their throats and make different sounds like humming, talking, or whispering. What do they feel? Sound is made when something vibrates, or moves back and forth. Air from the lungs pass through the vocal cords and cause them to vibrate. This helps us speak. If possible, pluck a guitar string or a rubber band to show how it vibrates. When something vibrates, it pushes particles of matter and causes them to compress. That compression then creates another next to it, and these compressions travel through matter as a wave of energy. These are sound waves. The sound waves travel through the air and to our ears and cause our eardrums to vibrate, helping us hear. Have children imagine throwing a rock in the middle of a pool or pond. Small waves move away from the rock along the surface of the water. These waves are similar to how sound waves travel through the air.

Volume describes how soft or loud a sound is. Students should know that volume, or loudness, is measured in units called decibels, with rustling leaves having a decibel level of 10, while a loud concert can have a level of 120 dB or above. If possible, use a stereo to demonstrate different volumes. The waves of loud sounds have a lot of energy and can travel far. This is why you can hear a fire truck siren or a school bell without being near it. Their sound waves can travel greater distances than softer sounds. The waves of softer sounds, such as a squeaking mouse or a whisper, do not have as much energy. You have to be pretty close to the source in order to hear them.

Pitch describes how low or high a sound is. If possible, use a stringed instrument or sing to demonstrate low notes and high notes. When you play a high note on a guitar, the string vibrates quickly and the sound waves move at a fast rate. When you play a low note, the string vibrates slower and the sound waves move at a slower rate. Remind children that just because something vibrates slower, it does not mean it’s softer. You can use a bass drum or a tuba to play low notes very loudly. The rate of vibration affects the pitch, but the amplitude, or height, of the sound wave determines the volume.
Sound waves need matter to move through, which means they cannot travel through a vacuum. Most of the sounds we hear travel through the air, but sounds can also travel through solids. Have children put their ear to a table and knock on the other side. They can hear the sound, and they will be also able to feel the vibration of the sound waves travelling through the wood. Sounds can also be blocked or absorbed by certain objects. Have children notice the difference in sound when a door or window is opened or closed. The door or window blocks out some of the sound waves and keeps them from reaching your ears. Earplugs are made to absorb some sound waves so they don't reach your ears. People who work in loud environments, such as construction workers or ambulance drivers may use earplugs to protect their ears and hearing.

Sound waves can also bounce off things. An echo occurs when a sound bounces off something and returns to the source, or where it came from. Have children share experiences when they have heard echoes. Where were they? What did they say or hear? Some animals such as bats and dolphins use echoes to help them navigate and hunt. Bats emit a sound and use the echo to help find their way and look for food. Dolphins make a clicking noise that creates sound waves that bounce against surrounding objects; when the sound is reflected back, the dolphin can use it to visualize an image. This is known as echolocation.
TELEPHONES

WEEK 2

Telephones: The Best Medium for Sound to Travel

Next Generation Science Standards (NGSS):

1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

Supporting Materials & Prep:

How to create a Basic Telephone

Materials:

- Prepared phones:
- 1 Phone with Fishing Line
- 1 Phone with String
- 1 Phone with Jewelry Wire

Setting the Stage:

Ask students: When you talk on the phone, how does your voice travel?

Explain the objective for the day: Today we will be investigating which “phone” will make our voices the loudest (with the most volume) when they travel from one person to another. Show students the different materials that they will be testing out for “phone cords”. Have them make predictions about which cord will make their voice travel the best (loudest) and why.

Activity Instructions:

1. Before trying out phones, review what the cords will be doing to produce sound (vibrating). Then model for them with 2 students holding phones and keeping the cord loose. Have them talk into the phone. Have other students watch the cord. Ask, “Do you see the cord vibrating?” “Why or why not?” Then have the same students pull the cord tight and talk. Ask, “Do you see the cord vibrating this time?” “Why or why not?” Ask, “How should we have the cord when we are testing them out? Loose or tight?” (Tight) “Why?” (Because the cord will vibrate better when it is pulled tight.)

2. Have each group explain which phone worked best (produced the loudest volume) and why they think it work best.

3. Reflect on what worked the best and why.

4. Tell them that they will be testing phones next week again, but they will be investigating which kind of hearing device will produce the most volume. (Plastic cup, metal can, Styrofoam cup)

Before You Begin:

K-1: Prepare telephones with different cords in advance. Have students work in groups of 6-8 and try out the phones to figure out which cord makes their voice travel better (louder). You will want to prepare 1 phone with fishing line, 1 phone with string, 1 phone with jewelry wire and 1 phone with yarn for each group of students.

Objective (s):

To create a protective covering for a water balloon (like a helmet for your brain) using soft & protective materials.
Instructions on how to create a basic telephone: (For teacher reference- not to read aloud to kids. Let them try and discover how!)

- With the push pin, carefully poke a small hole in the bottom of each plastic cup.
- Tie the paper clip to one end of the string.
- Thread the other end of the string through the hole in the bottom of one of the cups. Be sure to thread it from the inside of the cup. The paperclip will keep the string from going all the way through the hole.
- Then thread the string through the hole in the second cup, but this time, do it from the outside of the cup.
- Tie the second paper clip to the other end of the string. The paper clip should be inside the cup, just like the first paper clip.
- Then, pull the cups so that the string is tight and have one person talk into the cup while the other person holds the cup to their ear.
Next Generation Science Standards (NGSS):

1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

### Supporting Materials:
- Phones from previous week

### Materials:
- The best cord from last week's investigation
- Sets of phones for each group:
  - 1 Phone with Styrofoam Cups
  - 1 Phone with Small Plastic Cups
  - 1 Phone with Big Plastic Cups
  - 1 Phone with Tine Cans

### Setting the Stage: 2-5 Minutes

**Ask** students: Do you remember which cord helped us produce the highest volume last week? What could we see it doing as people talked? (vibrating)

**Explain** the objective for the day: Today we will be investigating which container produces the highest volume. (Show them the different containers.) Then have them make a prediction and share why. Remind them of how they want to pull the cords tight to produce the best vibrations.

### Activity Instructions:
1. Have students get into groups of 6-8 and investigate the different containers.

2. Have each group explain which container worked best (produced the loudest volume) and why they think it worked best.

3. Reflect on what worked the best and why.

### Variations/ Alternatives:
1. Have each student make a phone to take home. (Use the best cord and container type.)

### Objective(s):
Students will determine which container helps sound travel the best and produces the highest volume.

As students are trying out the phones, listen to the vocabulary they are using. Push them to use the sound vocabulary.

### Instructor Notes:

TELEPHONES
PART 2
WEEK 3
Telephones:
The Best Sound Piece

Unit 4: Sound

K-1
30 Minutes

K-1
Next Generation Science Standards (NGSS):

1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

Objective(s):
Students will order their pop bottles from lowest to highest sounds (pitch).

Instructor Notes:

Activity Instructions:
1. As students are participating in the investigation, the teacher should go around and listen to their conversations. Push them to use the new vocabulary (pitch, high, low, vibrations).

2. Once groups have ordered their bottles, ask them to tap the different bottles and figure out which water vibrates faster. Is it the high pitch sounds or the low pitch sounds?

3. Groups that finish early can try to play a song. Can they play Twinkle, Twinkle, Little Star? Mary Had a Little Lamb? Do they need to add more water to get the correct pitches?

4. Reflect and chart what students learned. To add to the discussion, put the tuning forks in order, lowest to highest. Play each one for the students. (You will need to walk close to students with tuning fork for them to hear it.) Have them watch and compare the vibrations of the low notes to the high notes. How are they vibrating differently? Add to reflections.
Ordering Pitch from High to Low

Next Generation Science Standards (NGSS):

1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

Materials:
- Process Grid
- Bag of Long Nails
- Bag of Long Screws
- Bottle Caps
- Pennies
- Large Paper Clips
- Large Safety Pins
- Wooden Skewers (to tap with)
- 4 Sounds Contraptions
- Tape
- Piece of 2x4” Cardboard for each student

Setting the Stage: 2-5 Minutes

Remind students of what they did last week with the soda bottles. Show them the sound contraptions and ask them to predict which sound contraption they think will make the highest sound? Which one will make the lowest sound? Have them listen and help you order them.

Explain objective of day: Each student will design their own sound contraption that has 4 sounds in order from high to low (remind them- pitch, not volume!)

Activity Instructions:

1. After each student chooses 4 objects to use in their contraption, have them begin ordering them and taping them on the cardboard. As they use their wooden skewer to tap with, they should listen to the sounds and then re-order them based on their pitch until their 4 objects are in order from highest to lowest.

2. When done, have them prove that their objects are in order by tapping their objects for another student. Students can help each other reorder their objects if necessary. (Students should be using new vocabulary!)

3. Reflect: Which object made the highest sound? Why do students think that that object made a higher sound? Which sound made the lowest sound? Why? Push them to use the new vocabulary. What other objects could they use if they made an instrument with high and low notes? Why?
**SOUND TRAVELS**

**WEEK 6**

*Traveling Sounds*

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**Next Generation Science Standards (NGSS):**

1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

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**Materials:**

- Set of Tuning Forks
- Gallon size Bag of Water
- Notebook
- 1 T-Chart copy for each group (next page)

- Books
- Backpacks
- Other objects available: tables, doors, floors, etc.
- Bag of Cotton Balls
- Piece of Paper

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**Setting the Stage: 2-5 Minutes**

**Ask** students to raise their hand if they think that sound can travel through the air. Then knock on the table and have them raise their hands when they hear the noise. Ask if they think that sound can travel through water. Then have a student come up and put the bag of water up to their ear. Snap on the other side of the bag and have them raise their hand if they can hear it. Ask students if they think that sound can travel through solid objects. (Describe what solid objects are.) Then have a student put their head to the table and knock at the other end. Have them raise their hand if they can hear the sound.

**Explain** objective of the day to the students: They will be using a tuning fork to find through which objects sound travels best and through which objects sound doesn’t travel best. (Teach them how to “activate” the tuning forks.)

**Objective (s):**

Students will use a tuning fork and place it on different objects in order to find out through which material sound travels best, and through which material sound doesn’t travel well.

**Activity Instructions:**

1. Have students work in groups. Each group will need a tuning fork to share. Put objects around the room for them to investigate. Have each group use the t-chart to record their data. Then they can put a star by the object through which that sound traveled best.

2. Reflect: Have groups share through which object sound traveled best. Why do they think sound traveled best through that object? Which object didn’t work so well? Why?
<table>
<thead>
<tr>
<th>Sound travels well through these objects.</th>
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<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Sound does NOT travel well through these objects.</td>
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</tbody>
</table>
# Amplifying Sounds

## Unit 4: Sound

### Next Generation Science Standards (NGSS):

1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

## Supporting Materials & Prep:

### K-1

| 30 Minutes |

None

## Materials:

- Notebook Paper
- Cardstock
- Tape
- Construction Paper
- Scissors
- Picture of a Megaphone

## Setting the Stage: 2-5 Minutes

**Ask** students if they can make their voice louder by using their hands. Why does that make their voice louder? Have each student yell their name to you by cupping their hands and forming a “megaphone”.

**Explain** today’s objective: Students will try to design a megaphone that amplifies their voice to the greatest volume. Show them a picture, but don’t show them how to make their megaphone.

## Activity Instructions:

1. Students can choose which material they will use first to make their megaphone. When they have made their first megaphone, have them test out the volume.

2. Have them change something about their first megaphone to design a megaphone that produces greater volume. (Size, shape, paper)

3. Keep working as long as time allows.

4. Reflect on what worked best. Have students say their name as loudly as possible into their megaphone. Determine which megaphone produces the greatest volume. Discuss why the students think that.
**VIBRATING MUSICAL INSTRUMENTS**

**WEEK 8**

*Rubber Band Mini-Guitar*

**Next Generation Science Standards (NGSS):**

1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.*

4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

**K-1**

<table>
<thead>
<tr>
<th><strong>30 Minutes</strong></th>
<th><strong>Supporting Materials &amp; Prep:</strong> None</th>
</tr>
</thead>
</table>

**Materials:**

- Multicolored Rubber Bands
- For Each Student:
  - 1 Milk Carton
  - 2 Used Pencils (may need to cut in half if too long for carton)

**Setting the Stage: 2-5 Minutes**

**Ask** students if they have ever played an instrument before. See if they know that the notes go in order from lowest to highest or highest to lowest.

**Explain** today’s objective: They will be making a finger guitar with rubber bands. They will need to decide which 4 rubber bands to use (4 different colors) and they will need to put them in order from highest to lowest.

**Activity Instructions:**

1. After students choose their 4 rubber bands, they should start testing them to see which makes the highest sound and so on. Decide on an order from highest to lowest.

2. Tape the two pencils to the carton, using figure above as a guide. Then stretch the rubber bands in order over the wide side of the milk carton. Add to process chart what they discover.

3. After students have their guitars ready, show them how to write a song by drawing notes with the colors of their rubber bands.

4. Reflect: Ask students to see if they can visually see a difference in the vibrations of their high notes and their low notes. What do they notice? Why? Add to process chart.
Next Generation Science Standards (NGSS):
1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.
1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.
K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

**Objective(s):**
Students will create an instrument that has vibrating pieces, produces high and low sounds and has a way to amplify the volume.

**Instructor Notes:**
Activity Instructions:
1. As students are creating their instrument, listen for the vocabulary that they have learned throughout the unit. Push them to use the new vocabulary.

2. Have students share their instruments. Ask them to use the new vocabulary as they describe their instrument.

3. Reflection: Have students reflect on what they learned during the sound unit. What do they want to try at home?
Before you begin the activity, please hand out the pre-test to each student. The pre-test has two different grade levels, make sure to use the correct one for your age group. The pre-test will help us evaluate how effective this unit is on teaching kids about the engineering method. At the end of the quarter the same test will be administered again to see how much knowledge students have gained.
**Kinder-1st Grade**

Draw and/or write about the 6 steps in the engineering process and put them in the correct order.

<table>
<thead>
<tr>
<th>1.</th>
<th>2.</th>
<th>3.</th>
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<tbody>
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<td>4.</td>
<td>5.</td>
<td>6.</td>
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</table>

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Create a Model</td>
</tr>
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<td>2.</td>
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<td>3.</td>
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<td>Explained what You Learned</td>
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<td>5.</td>
<td>Test Your Model</td>
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<tr>
<td>6.</td>
<td>Think of a Problem</td>
</tr>
<tr>
<td>What is the Problem?</td>
<td>Explain what You did and learned</td>
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<td>---------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Improve Your Model &amp; Retest</td>
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<td>Assembly Component Design Model Prototype System Technology</td>
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<tr>
<td>?</td>
<td>Problem Constraints Criteria</td>
</tr>
</tbody>
</table>
**INTRO/ PAPER CUPS**

**WEEK 1**

*Paper Cups*

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**Unit 5: Wind**

**Next Generation Science Standards (NGSS):**

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

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**K-5**

**30 Minutes**

**Prep:**

Pre Tests

**Materials:**

- Process Grid
- Small Paper Cups
- Scissors
- Box Fan

**Setting the Stage:**

**Ask** students: “What have you seen the wind do?”

**Explain** the objective for the day.

**Place** a non-cut cup above the fan (turned on) and time it.

**Ask** students if they can cut the cup to make it stay in the air longer?

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**Objective(s):**

Students will create a cup that floats by using the wind’s force.

**Instructor Notes:**

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**Activity Instructions:**

1. Give students one cup today to try out. Have students fill in their Process Grid with what they are trying, under the “Create a Model” section.

2. When students have designed their cup, have them test it and time it. Have them add their results to Process Grid. Ex: 1 cup fell to the ground and didn't work; Floated for 10 seconds.

3. Have them reflect on their cup and the changes that they might make to it next week. Have a couple of students share their ideas for improving their cup for next week and prompt them to write their ideas on their Process Grid under “Improve your Model”.

4. Have students write their name on their cup and teacher collects for next week.
Paper Cups Engineering Part 2

Unit 5: Wind

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K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

K-5

30 Minutes

Supporting Materials & Prep:
None

Materials:
- Process Grid
- Small Paper Cups
- Box Fan

Setting the Stage:

Review Last week's process and results. Use Process Grids from last week.

Explain the objective for the day, and that they will try to improve upon their cups from last week.

Ask students if they can cut the cup to make it stay in the air longer?

Objective (s):
Students will modify a cup that floats by using the wind’s force.

Activity Instructions:

1. Ask students to look at their cup from last week and discuss with a partner how well it worked, what they might want to do to change it and why. Have them fill in their ideas on their Process Grid, and then share a couple of ideas whole group.

2. Do experiment again (same as previous week) Continue to have students add ideas and results to Process Grid.

3. At the end of the lesson, look at 1-2 examples of cups that worked really well and ask students what they learned about “wind energy” from this engineering project. (Why did they work well?) Have them add what they learned to their Process Grid.
**SEEDS TRAVEL**

**K-5 30 Minutes**

**Supporting Materials & Prep:**
None

**Materials:**
- Tape
- Regular Paper
- Paper Clips
- Tissue Paper
- Construction Paper
- Straws

**Setting the Stage:**

**Explain** to students that trees in a forest have a problem. If they are too close together, they don't get enough water or sunlight and they won't grow. They need to have seeds that will travel so that each tree has its own space. You must design a seed that will travel as far as possible away from the drop point (Drop point is with their feet even to the fan). Fill in problem on Process Grid.

**Brainstorm** a couple of ideas of what might work. Fill in on Process Grid.

**Activity Instructions:**

1. Students are given materials to design a seed that will travel. Let them experiment and try different approaches to creating their seed.

2. As students finish, they will bring their seed up, stand by fan and drop it. Then they will measure how far it traveled until it came to a complete stop (rolling counts!). Student will mark on their Process Grid how far their seed went. Then student goes back and tries to redesign their seed to make it go farther.

3. At the end of the lesson, look at 1-2 examples of seeds that worked really well and ask students what they learned about “wind energy” from this engineering project. (Why did they work well?) Have them add what they learned to their Process Grid.
K-1

SAILBOATS

WEEK 4

Sailboats

Next Generation Science Standards (NGSS):

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

K-5

30 Minutes

Supporting Materials & Prep:

Prior to the lesson, Instructor must create 2 cardboard boats for students to attach their sail to, in order to race their sail.

Materials:

- Fan
- Tape
- Cardstock
- Fishing Wire
- Cardboard Boats
- Wax Paper
- Straws
- Craft Sticks (Popsicle)
- Regular Paper

Setting the Stage:

Explain the objective of the day.

Show them the pre-made cardboard boats and explain they will be creating sails to attach to the boats.

Brainstorm ideas about what makes a boat go fast.

Objective(s):

Students will order their pop bottles from lowest to highest sounds (pitch).

Instructor Notes:

Activity Instructions:

1. Students can create their own sail, or they can collaborate and work in small groups to create a single sail. Let them experiment with the materials.

2. When 2 students have their sails ready, they bring them up to race. Race boats by setting them on the floor in front of the fan, and seeing which boat travels further. Have students write their results on their Process Grid. Ex: The triangular one went faster. Mine didn’t win because it was too small. Students can draw the shape that they tried on a sticky note and put under a fast or slow column the teacher has created on the wall.

3. The “winning” sail will stay in the boat and the students go back to redesign.
   a. NOTE! For this week, have students focus on material when redesigning, but remember other factors (shape, size, etc.) for upcoming weeks.

4. Someone else that has a sail ready challenges the “fastest” sail.

5. At the end of the lesson, look at 1-2 examples of sails that worked really well and ask students what they learned about “wind energy” from this engineering project. (Why did they work well?) Have students add what they learned to their Process Grid.
SAILBOATS

PART 2

WEEK 5

Change Shape of Sail

Next Generation Science Standards (NGSS):

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

K-5

Materials:
- Same as previous week:
  - Fan
  - Tape
  - Regular Tape
- Fishing Wire
- Cardboard Boat
- Craft Sticks
- Straws
- Wax Paper
- Cardstock

Supporting Materials:
Cardboard Boat from previous week

Objective(s):
Students will manipulate factors to create the fastest sailboat and understand wind energy.

Instructor Notes:

Activity Instructions:
1. Students can create their own sail, or they can collaborate and work in small groups to create a single sail. Last week they experimented with different materials, this week have them focus changing the shape and/or size of their sail. Have them record their ideas on their Process Grid.
   a. NOTE! For this week, have K-3 students focus ONLY on changing the shape of their sail when redesigning (they will do size next week), and have 4-5 students focus on changing the size AND shape of their sails.

2. When 2 students have their sails ready, they bring them up to race. Race boats by setting them on the floor in front of the fan, and seeing which boat travels further. Have students write their results on their Process Grid. Ex: The triangular one went faster. Mine didn’t win because it was too small. Students can draw the shape that they tried on a sticky note and put under a fast or slow column the teacher has created on the wall.

3. The “winning” sail will stay in the boat and the students go back to redesign.

4. Someone else that has a sail ready challenges the “fastest” sail.

5. At the end of the lesson, look at 1-2 examples of sails that worked really well and ask students what they learned about “wind energy” from this engineering project. (Why did they work well?) Have students add what they learned to their Process Grid.
SAILBOATS/WINDMILLS

WEEK 6
Change Size of Sail

K-3
30 Minutes

Supporting Materials:
Cardboard Boats from previous weeks

Materials:
- Same as previous week:
  - Fan
  - Tape
  - Regular Paper
- Fishing Wire
- Cardboard Boat
- Craft Sticks
- Straws
- Wax Paper
- Cardstock

Setting the Stage:
- Review sailboats and ideas from previous weeks.
- Brainstorm ways they can change the size of their sail to make the boat go faster.

Objective(s):
- Students will manipulate factors to create the fastest sailboat and understand wind energy.

Instructor Notes:
- Activity Instructions:
  1. Students can create their own sail, or they can collaborate and work in small groups to create a single sail. Last week they experimented with different materials, this week have them focus changing the shape and/or size of their sail. Have them record their ideas on their Process Grid.
    a. NOTE! For this week, have K-3 students focus on changing the size of their sail when redesigning.
  2. When 2 students have their sails ready, they bring them up to race. Race boats by setting them on the floor in front of the fan, and seeing which boat travels further. Have students write their results on their Process Grid. Ex: The triangular one went faster. Mine didn’t win because it was too small. Students can draw the shape that they tried on a sticky note and put under a fast or slow column the teacher has created on the wall.
  3. The “winning” sail will stay in the boat and the students go back to redesign.
  4. Someone else that has a sail ready challenges the “fastest” sail.
  5. Challenge students to design a sail that uses the best material, the best size, AND the best shape.
  6. At the end of the lesson, look at 1-2 examples of sails that worked really well and ask students what they learned about “wind energy” from this engineering project. (Why did they work well?) Have students add what they learned to their Process Grid.
## PINWHEELS/ WINDMILLS

### WEEK 7

**Pinwheels**

### Supporting Materials & Prep:

Pre-make pinwheel frames for K-1 students: 2 straws attached in an “x” to a pencil with a thumbtack through the eraser.

### Materials:

- Tape
- Cardstock
- New Pencil with Full Eraser (1 per pair)
- Thumbtacks (1 per pair)
- Construction Paper
- Straws (4 per pair)

### Setting the Stage:

**Explain** objective of day. Have students fill in problem on Process Grid.

**Brainstorm** a couple of ideas of what might work and why. Fill in ideas on their Process Grid.

### Activity Instructions:

1. Pairs of students are given materials to design their pinwheel. K-1 students will be given the frame pre-made: 2 straws attached to pencil with thumbtack.
2. Let students experiment with designing blades for their pinwheel and taping them to the straws.
3. As students finish, they will bring their pinwheel, stand by fan and try to count rotations. (Draw an X on one of the blades for counting.) Students will mark on their Process Grid with how fast their pinwheel went. Student will know they have a very fast pinwheel when they can no longer count the rotations. Then student goes back and tries to redesign their pinwheel to make it go faster.
4. At the end of lesson, discuss with students which types of blades seemed to work best. Have them record their progress on their Process Grid.
5. Collect pinwheels and save for next lesson.

### Objective(s):

Students will design pinwheel blades that will go as fast as possible.

### Instructor Notes:

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3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
**Objective (s):**

Students will design pinwheel blades that will go as fast as possible.

**Instructor Notes:**

Activity Instructions:

1. Have students continue designing new blades and testing which blades go the fastest. Ask them to record the results in the Process Grid. Prompt them with ideas for shape and size changes if they are stuck.

2. Look at 1-2 examples of pinwheels that worked really well and ask students what they learned about "wind energy" from this engineering project. (Why did they work well?) Have them record what they learned on their Process Grid.
Wrap Up

Week 9: Wrap Up

Next Generation Science Standards (NGSS):
K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Objective(s):
Reflect what they’ve learned from the wind unit and how they might use what they’ve learned to test other wind experiments.

Instructor Notes:

Activity Instructions:
1. Review the Process Grid with students. Ask them to think about all the projects they have done in this unit. Then ask them what worked best to make the wind work and what didn’t work. (Write ideas on their paper).

2. Use what you’ve learned. Have students draw a picture of a kite that would fly the best in the wind. What would it look like?

3. Discuss the kites, and why students think they would work. Students can take their reflection home to share what they have learned.

4. In the last 10 minutes, have students take the Post-Test. Make sure to give the correct test to the correct grade level.