Farmer Grady's Challenge

Home Connection

Dear Family,
During the last few days, the students designed models of coverings that would protect orchards from hailstorms. They acted just like engineers! They…

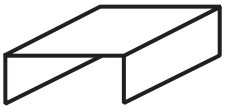
- identified and learned about a problem
- planned ways to solve the problem
- made and tested a model
- revised their design to make it even better

In this challenge, students developed understanding about the structural strength of different shapes, engineering design, how hail forms and its effects, and adhering to a budget. They also practiced skills such as developing and using models, making claims based on evidence, and communicating technical information.

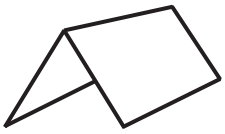
Let your child tell you in his or her own words about what the team did in this engineering effort and how the team used the various roof shapes and netting shown in the pictures. Prompt your child if he or she needs help.

- What was the problem you were solving?
- What were the criteria (goals or conditions) that your design had to meet?
- What constraints (limits) to cost and materials did you have to work with?
- How did you measure the success of your design?
- How did you improve your design? What information did you learn that led to your improvements?

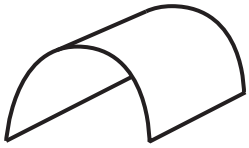
On the back of this sheet, work with your child to extend his or her work in the challenge.



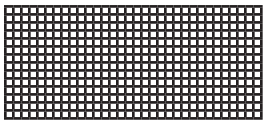
Flat roof



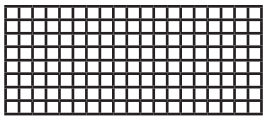
Pointed roof



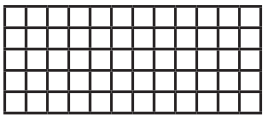
Arched roof



Narrow-weave netting



Medium-weave netting



Wide-weave netting

This STEM project has been developed in partnership with Texas A&M University.

Hands-On Standards STEM in Action

Farmer Grady's Challenge

Home Connection

About Hail

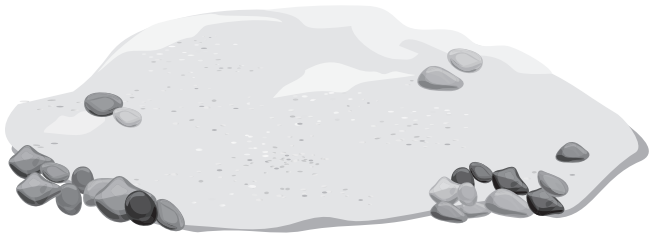
According to the National Oceanic and Atmospheric Administration (NOAA) hail falls most frequently in Nebraska, Colorado, and Wyoming, but hail-producing thunderstorms can occur anywhere in the United States. On average, hail causes nearly one billion dollars in damage to crops and property annually. Ask your child to explain how hail forms and how it can damage crops and property. Prompt your child, if needed.

- How big are hailstones?
- How do hailstones form?
- Why do hailstones look layered like an onion when cut in half?
- What happens to fruit when it is damaged by hail?
- What other kinds of damage can hail produce?

If you have access to the Internet, visit NOAA at **www.noaa.gov** and type "hail" into the search box. The first few results include images and more information.

Try It!

Your child can apply what the team learned about roof shapes and hail to build a safe home for a toy. Use craft supplies such as paper, craft sticks, tape, and pipe cleaners to build a covered structure. Discuss what shape the roof should be based on what we learned. Decide how tall the structure should be. Test the structure by pouring sand, salt, or pebbles over the top. Additionally, you can test how stable it is in windy conditions with a fan or hair dryer.



This STEM project has been developed in partnership with Texas A&M University.

Compare Roof Shapes

Name _____

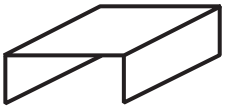
1. **Build** Fold index cards to model the 3 roof shapes below. Use a pea-sized ball of clay at each corner to secure the shape to the tray.

2. **Observe** Gently shake the contents of 1 salt packet onto each roof. What happens?

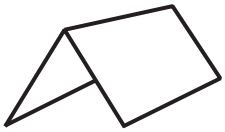
   Flat roof _____

   Pointed roof _____

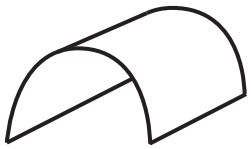
   Arched roof _____



Flat roof



Pointed roof



Arched roof

3. **Observe** Gently push down with a finger on the top of each roof. What happens?

   Flat roof _____

   Pointed roof _____

   Arched roof _____

4. **Compare** Which roof shapes allow salt to roll off?

   Flat roof Pointed roof Arched roof

5. **Compare** Which roof shape is most stable?

   Flat roof Pointed roof Arched roof

6. **Draw conclusions** Which would be the best shape for the shed roof? Why?

_____

_____

_____

_____

Compare the Weave

Name _____

Follow these steps.

1. **Analyze** Observe the gravel. Examine the three pieces of netting. Which of them will allow gravel to pass through? Record your predictions in the table.
2. **Measure** 1 tablespoon of gravel. Put it in a plastic cup.
3. Place a piece of narrow-weave netting across the top of the cup. Pull the netting tight. Carefully stretch a rubber band around the cup to hold the netting tight.
4. Hold the cup over the tray. Turn the cup upside down and gently shake it.
5. **Observe** the tray. Did any gravel pass through the netting? Record your observations in the table.

Size of Netting	Prediction Will Gravel Pass Through?	Observation Did Gravel Pass Through?
Narrow-weave		
Medium-weave		
Wide-weave		

6. Remove all of the gravel from the tray.
7. Repeat Steps 2–6 for the other two sizes of netting.
8. **Analyze** Which size(s) of netting allowed gravel to pass through? _____

_____

9. **Draw Conclusions** Were your predictions correct? Explain. _____

_____

_____

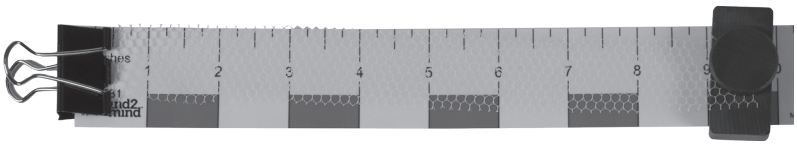
Compare the Strength

Name _____

Follow these steps.

1. **Predict** Examine the three pieces of netting. Predict which size of netting has the most tensile strength. _____

2. Lay the ruler on a flat surface. Use a binder clamp to attach a strip of narrow-weave netting to the top of the ruler. Make sure the base of the clamp is at $\frac{1}{2}$ inch.



3. **Measure** Attach the block and disk magnets to the netting at 9 inches.

4. Hold the ruler upright. Wait for one minute.

5. **Measure** the length of the netting between the clamp and magnets. Record this ending length in the table.

Size of Netting	Starting Length	Ending Length	Length Stretched
Narrow-weave	9 inches		
Medium-weave	9 inches		
Wide-weave	9 inches		

6. Subtract the starting length from the ending length. This is the length stretched. Record this length in the table.

7. Remove the binder clamp from the netting. Repeat Steps 2–6 for the other two sizes of netting.

8. **Analyze** Which netting stretched the most?

_____

9. **Draw conclusions** Which netting has the most tensile strength?

_____

10. **Draw conclusions** Was your prediction correct? Explain. _____

_____

_____

Crop Protector Design Plan

Name _____

Circle one: **My Crop Protector Design Plan** **Team Crop Protector Design Plan**

You may use only the following materials to plan a crop protector for your model orchard.

Craft sticks	Narrow-weave netting	Clay
Plastic straws	Medium-weave netting	Masking tape
Pipe cleaners	Wide-weave netting	

Think about your materials.

1. What shape will you build? Which materials will help you build that shape?

   _____

   _____

2. Which type of netting will you use? Why?

   _____

   _____

Draw a plan for your crop protector. Label all the materials.

Cost of Materials

Name _____

Follow these steps.

1. **List** the materials needed to build your model in the table. Use your **Crop Protector Design Plan** to make your list.
2. **Record** the quantity (amount) and cost of each item in the table.
3. **Multiply** the quantity by the cost per item to find the total cost for each material.
4. **Add** the total costs of all the materials to find the total cost of your model.

Material	Quantity	Cost per Item	Material	Quantity	Cost per Item
Craft stick	1	$0.25	Narrow-weave netting	1	$1.00
Plastic straw	1	$0.50	Medium-weave netting	1	$2.00
Pipe cleaner	1	$0.10	Wide-weave netting	1	$1.00
Clay	$\frac{1}{2}$ stick	Free	Masking tape	12 inches	Free

Material	Quantity	Cost per Item	Total Cost for Material
Example: Plastic straws	***4***	***$0.50***	***$2.00***
		Total Cost of Model	

Remember the constraint: Your total model cost may be no more than $6.00.

Crop Protector Test

Name _____

Follow these steps.

1. **Measure** Use a ruler to measure the size of your model.

   Height: _____ Width: _____ Length: _____

2. **Observe** Place your model in the testing station. Your teacher will pour $\frac{1}{2}$ cup of gravel onto your model. Observe what happens.

   • What happened to the model crop protector?

   _____

   _____

   • How many trees stayed upright? How many were knocked over?

   _____

   _____

   • Where did the gravel land?

   _____

   _____

   • What else did you observe?

   _____

   _____

3. Remove your model from the testing station.

4. **Measure** Put any gravel that fell *inside* of your crop protector in a cup. Use a teaspoon to measure the gravel.

   Amount of gravel that fell inside the model: _____

5. **Analyze** Does your model meet the criteria of the problem? Explain.

   _____

   _____

Reflect On It

Name _____

Use your plan, model, and test results to finish these sentences.

Crop Protector Plan

1. We chose (circle one) narrow/medium/wide-weave netting because _____

_____

2. We chose the shape of our structure because _____

_____

Model

Our model met these criteria:	Our model met these constraints:
☐ Be at least 8 inches long, 4 inches wide, and 6 inches high.	☐ Only materials provided may be used.
☐ Not collapse when $\frac{1}{2}$ cup of gravel is poured onto it.	☐ The cost of materials may be no more than $6.00.
☐ Allow no more than 1 teaspoon of gravel to fall inside during the test.	☐ The base of the model must fit on a tray that is 10 inches long and 8 inches wide.

3. One part of our design that worked well was _____ because

_____

4. One part of our design that did not work well was _____ because

_____

Compare Designs

5. We compared our model to Team _____. I observed that _____

_____

6. The most successful model was made by Team _____. It was successful because

_____