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INTRODUCTION

This book will help you implement engineering design challenges in your classroom by using stories as an entry point. This interdisciplinary approach helps students contextualize engineering and design concepts, and they will get excited about engineering!

The stories are fun and engaging and have been specifically developed to include several problems—some obvious and some not so obvious. Students read a story and look for and discuss the problems they find, which encourages them to reread and analyze the text of the story. Once students have chosen a problem, they work in teams to define what they need to create to solve it. Teams then use the engineering design process to plan, build, test, and improve their solution using recycled materials and common supplies. Finally, students reflect on their experience through writing. This integration of literacy and STEM allows students to acquire and practice skills in both areas.

Engineering challenges may be different from what you and your students are used to. Instead of lecturing or demonstrating, you will be putting materials in the hands of students, setting them up for success, and turning them loose to create and build. You become a facilitator—scaffolding when necessary; providing guidance; and checking in with groups to offer encouragement, advice, correction, and support. Motivate students to help one another, both within teams and between teams.

There may be a bit of a learning curve at first, but once students understand how engineering challenges work, they really dive into them. They become fully engaged in working together on their own terms, manipulating materials, and solving a compelling problem, with their hands and minds occupied and on task. And these challenges are not conducive to silence; a low buzz of purposeful conversation indicates that students are actively engaged. Your biggest problem may be getting them to wrap things up!

MATERIALS:

> **Suggested:** structural items such as craft sticks, index cards, straws, cardboard tubes, rulers, and yardsticks; containers such as cardboard boxes, plastic and paper cups, plastic bottles, egg cartons; small items such as packing peanuts, pom-poms, cotton balls, balloons; malleable materials such as trash bags, cupcake liners, lunch sacks, gift bags, clay; connectors such as rubber bands, pipe cleaners, string, tape, glue

PREPARATION:

Set up a testing station using a door. You just need to clear an area around the door and make sure it is unlocked. Full-size room doors are best, but cabinet doors will work in a pinch. You may want to provide a short stepladder for students to reach the top of the door.

LESSON PLAN:

1. Have students read the passage and discuss the problems they identified. Use these questions as prompts:

   - Are you or have you ever been in a club? What did the club do?
   - What are some of the projects the Second Floor Spy Club wants to do?

2. Introduce the Room Alarm Challenge by reading through the challenge pages together. Show students the available materials and review the criteria and constraints. Make sure they understand that their room alarms must be safe—they can't have anything fall off the top of the door to land on someone unless it's very light, like a towel or a balloon.

3. First, students will brainstorm the parts of their room alarms separately. Here are some possibilities:

   - Noisemakers: popping balloons, knocking down cans, hitting a container with a spinning spoon
   - Triggers: a string taped to the door and the door frame, something light balanced on top of a slightly ajar door, building a tower of objects that get knocked down when the door is opened (this will depend on which way the door swings!).

   If you have access to kid-safe electronics such as paper-circuit kits, those will work for this challenge as well.

4. Give students time to prepare, brainstorm, plan, and build their room alarms. Circulate to observe and answer questions as students work on their solutions. Remind them to use the challenge pages to guide them as they work through the engineering design process. When they are ready for testing, observe to ensure fair and equal testing conditions for each student or team.

5. Have students share their solutions with the class and get feedback from peers, then revise their designs and test again.

6. When students have completed the challenge, have them demonstrate and explain their room alarms for the class. Then have them fill out the reflection page.

7. If time, allow students to choose their own problem and testing setup and use the *Universal Challenge Pages* (pages 104–107) to complete their challenge.

NAME: _____ **DATE:** _____

Directions: Read the passage and underline the problems the characters face. Write and/or sketch your ideas for solutions in the margins.

SECOND FLOOR SPY CLUB

Grady knocked on the door of Apartment 2E. The door opened just a crack. "Hi! I'm here for the meeting," said Grady, trying to peer inside.

"What's the secret password?" came a voice from inside.

Grady looked around, then he leaned close to the door and whispered, "Pineapple and pepperoni pizza."

Aracelly swung the door open and said, "Welcome to the Second Floor Spy Club!" She led Grady into the kitchen, where Cora and Emma were already sitting at the table.

"Now that we're all here, let's get going," said Aracelly.

"But what about snacks?" asked Emma. They all agreed that snacks were important.

Aracelly got out a box of graham crackers and a bag of marshmallows. Six grabby hands reached for them all at once. "Hold on!" shouted Aracelly. She handed each club member four graham crackers and a dozen marshmallows. Three of them stuffed the snacks into their mouths as fast as they could. Emma skillfully stacked hers to build a tower, then carefully removed one item at a time from the top and ate it.

"Aw man," sighed Grady. "I wish you'd showed us that before we scarfed down all our building materials!" Everyone laughed.

"Okay, now that we've had our snacks, this meeting of the Second Floor Spy Club is officially started!" proclaimed Cora. "Aracelly, what is our first order of business?"

"I think we need to improve our communications," said Aracelly. "I want to send secret messages across the alley to Grady from my bedroom window to his bedroom window."

"Since we're all on the second floor, I think we should be able to send messages to all of our windows," said

NAME: _____   DATE: _____

SECOND FLOOR SPY CLUB

Emma. Aracelly and Emma lived next to each other in one building, and Grady and Cora lived next to each other in the building across the alley.

"Maybe the messages should be in secret code," said Grady, "in case someone tries to intercept them."

"Great idea, Grady!" said Cora. "All in favor of this project, raise your hand." All four club members agreed that this was a great idea and voted to approve the project.

"I have the next order of business," said Emma, sounding aggravated. "I just know my annoying little brother has been in my room. Yesterday, my door wasn't closed all the way and my favorite book was missing. I need a way to prove he has been trespassing."

The club discussed the possibilities. Aracelly thought they should put a string across the door that would set off an alarm if a sneaky little brother opened it. Grady thought that it should trigger a loud noise like a balloon popping. Emma wanted to stack up a bunch of boxes that would get knocked over when the door was opened. Aracelly thought they should rig something to splash paint on him, like the exploding dye packs they use to catch bank robbers.

"Sounds like we have lots of great ideas. All in favor of building a little brother alarm?" asked Cora. They all raised a hand.

Grady watched Emma pop her last marshmallow into her mouth, and he called out, "I vote we end this meeting and get more snacks!"

"All in favor of more snacks?" asked Aracelly. The vote was a unanimous yes.

STEP 1: PREPARE FOR THE CHALLENGE

Problem	Challenge	Criteria	Constraints
What problem will you solve?	What will you do?	What should the solution do to be successful?	What are the limits?
Emma's little brother has been sneaking into her room.	Create a room protection system that will make a loud sound when someone opens a door.	• The alarm should make a noise when triggered. • The alarm should be triggered by the opening of a door.	• Use only the materials given. • The system cannot cause any injury or harm. • Do not make a mess that you cannot quickly and completely clean up.

For this challenge, you will need to design several parts that work together:

- Something that will make a noise
- A way to trigger the noise when the door is opened
- Anything else you want to include, as long as it's safe!

Directions: Quickly brainstorm at least five ideas for each part of your room alarm system. Don't worry about how they work together yet.

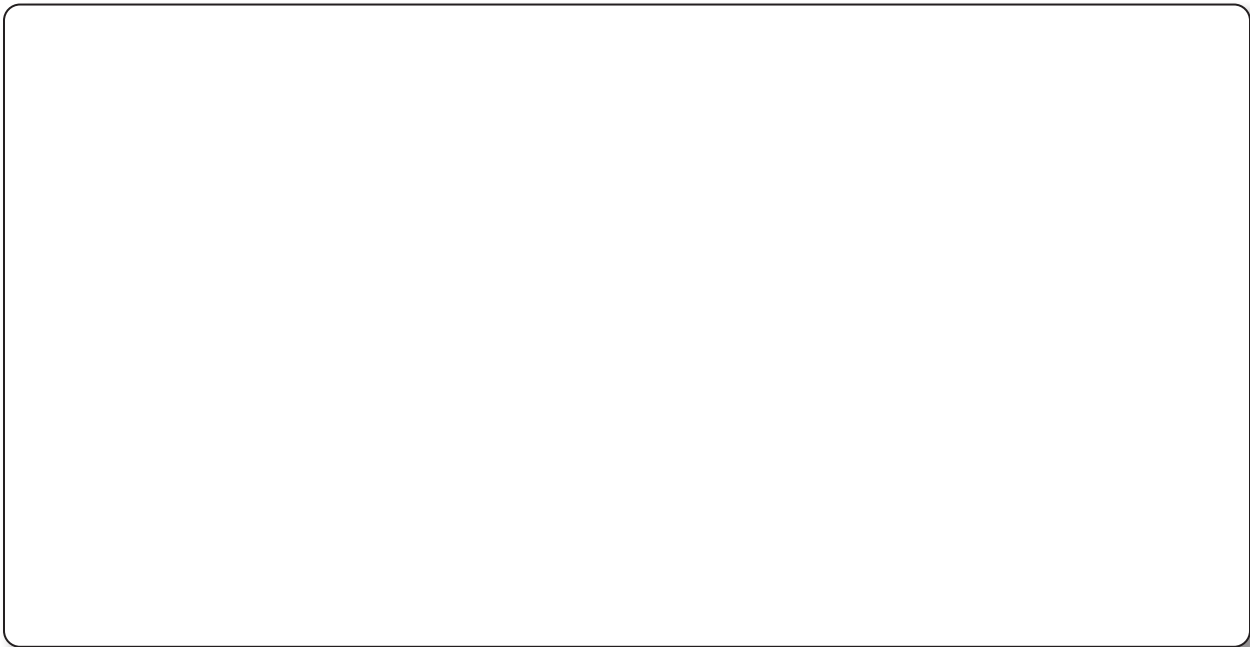| Noise-making part	Door-opening trigger part	Other parts

STEP 2: BRAINSTORM, PLAN, AND BUILD

1. Now think about which ideas for triggers and noisemakers will work best together. Brainstorm design ideas for room alarm systems you can build that will meet the criteria and constraints. Sketch and write at least three ideas on the back of this page.

2. Think about which design might perform best in testing. Draw a star by the design you will build. Why did you choose this idea?

_____

_____

3. Draw a diagram of your design here. Label all of the materials.

4. Describe how your room alarm will be triggered.

_____

_____

5. Describe how your room alarm will make a noise.

_____

_____

6. Build your room alarm according to your plan!