SIEMENS STEM DAY | Science Technology Engineering Math

GRADES 9–12

SIEMENS STEM DAY ACTIVITY

BUILD A BUNGEE

OBJECTIVES

Students will be able to:

- Plan, carry out, and analyze an investigation.
- Plot data from an experiment and then derive the line of best-fit for the given situation.

THIS LESSON FOCUSES ON

Engineering Design Cycle

- Communicating Results

21st-Century Skills

- Collaboration
- Communication
- Critical Thinking

OVERVIEW

Students will simulate a safe bungee jump using rubber bands and a small doll or action figure. Through experimentation, students will generate a linear equation to represent the relationship between the number of rubber bands and the distance the doll/action figure traveled.

STEM incorporates Science, Technology, Engineering, and Mathematics to focus on real-world issues and problems guided by the engineering design process. This type of instruction supports students in developing critical thinking, collaboration, reasoning, and creative skills to be competitive in the 21st-century workforce.

Each Siemens STEM Day classroom activity highlights one or more components of the engineering design cycle and an essential 21st-century skill.

MATERIALS

- Materials for experimentatio—rubber bands, small lightweight dolls or action figures (one per group), meter sticks
- Goggles—one per person
- Cell phones for video purposes—one per group
- Computers with internet access
- **Build a Bungee** Handout—one per person
- **Build a Bungee Data Collection and Analysis** Handout—one per person

HAVE YOU EVER WONDERED . . .

How bungee jumping could possibly involve mathematics?

NATIONAL STANDARDS

Standards for Technology Literacy	Standard 3: Students will develop an understanding of The Nature of Technology. This includes inquiring a knowledge of the relationship among technologies and the connections between technology and other fields. Standard 10: Students will develop an understanding of Design. This includes knowing about the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
Next Generation Science Standards	HS-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. SEP3: Planning and Carrying Out Investigations SEP4: Analyzing and Interpreting Data SEP5: Using Mathematics and Computational Thinking
Common Core Math State Standards	CCSS.MATH.CONTENT.HSA.REI.D.10: Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). CCSS.MATH.CONTENT.HSS.ID.B.6.C: Fit a linear function for a scatter plot that suggests a linear association. CCSS.MATH.CONTENT.HSS.ID.C.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. MP2: Reason Abstractly and Quantitatively MP4: Model with Mathematics

MAKE CONNECTIONS!

How does this connect to students?

For the doll/action figure to have a safe jump, it is necessary to analyze the factors that affect safety. This simulation serves as a reminder to students that it is extremely important to consider **safety measures** before acting upon their choices.

How does this connect to careers?

A **physicist** is responsible for explaining how various forces interact and affect the natural world. Problem solving, critical thinking and analytical application skills are a few of the key strengths needed to be a physicist. Physicists work within the field and in lab settings to experiment, analyze data, and draw conclusions that contribute to a better understanding of the physical world.

Materials engineers are responsible for developing, processing, and testing materials that are used in a range of products. Bungee cords rely upon the principle of elasticity to safely reduce the forces acting upon the jumper. Materials engineers would find themselves monitoring the performance of different material types used to create the bungees.

How does this connect to our world?

Line of best-fit is also referred to as a regression line because it is useful as a prediction tool. This is frequently used in the business world to help companies make predictions about future needs.

Bungee jumping is a form of high adrenaline **recreation**. Many thrill seekers travel great distances to jump from specific locations such as the Grand Canyon.

BLUEPRINT FOR DISCOVERY

1. To engage students in what they will be learning, ask them to guess what the highest known bungee jump is. After everyone has had an opportunity to guess, explain that according to the Guinness Book of Records, the highest commercial **bungee jump** in the world is 764 ft (233m), off the Macau Tower in China. To further peek the students' interest, play the following video that shows a bungee jump from a helicopter over the Grand Canyon. https://www.youtube.com/watch?v=KSu6gRp7UBA&t=132s
2. Explain to students that their mission is to construct a bungee for their doll/action figure that is both safe and thrilling. The goal is to predict the number of rubber bands needed to make a safe bungee jump from 2 meters.

3. Split the students into small groups of 3–4 students. Then distribute the experimental materials (rubber bands, a doll/action figure, meter stick) and one copy of the **Build a Bungee** Handout to each student.
4. Before the groups begin experimenting, review the necessary safety precautions. Students should be instructed to wear goggles and take safety precautions when dropping the doll/action figure from various heights.
5. Instruct the students to collaboratively work with their team members and remind them to closely follow the directions. As the students are experimenting, be sure to circulate around the room visiting each group to answer questions and reinforce safety precautions.
6. Conclude the lesson by facilitating a discussion about each group's prediction accuracy and learning. Ask each group to share their findings and explain what they learned from this simulation.

TAKE ACTION!

Students can use the following website to complete a Bungee Barbie Challenge Desmos digital activity.
https://teacher.desmos.com/activitybuilder/custom/5663c9c0899c1f511547a5ca

BUILD A BUNGEE HANDOUT

Within your small group use the provided materials to construct a bungee for a doll/action figure that is both safe and thrilling. The goal is to predict the number of rubber bands needed to make a safe bungee jump from 2 meters.

Materials

- Small doll or action figure
- 10–15 rubber bands
- Meter stick
- Cell phone (for video purposes)

The independent variable is the number of rubber bands used, and the dependent variable is the drop height. Experiment to determine the interdependent relationship between these two variables. Additionally, graph the data and create a mathematical equation that represents the situation.

Procedure

Figure 1

1. Measure and record the height of the doll/action figure in meters.

   Doll/action figure height: _____ meters

2. Use a slip knot (refer to Figure 1) to attach one rubber band to the foot of the doll/action figure.
3. Decide the height off the ground that your group will consider to be a "safe" jump. In other words, how far off the ground would you consider to be safe for your doll/action figure's head to land?

   Safest height off the ground:_____ meters

4. All groups will use 2 meters as the maximum drop height. Predict how many rubber bands will be needed to complete a "safe" jump.

   Number of rubber bands that will be needed:_____

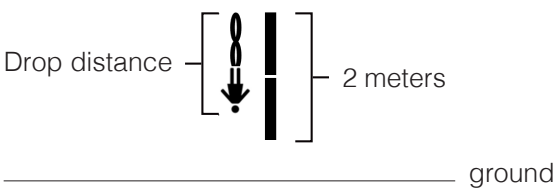
5. Start experimentation by adding one rubber band at a time to the end of the previous rubber band. When the doll/action figure is dropped, be sure to hold its feet at 2 meters and release it from there. Be sure to hold the end of the last rubber band at the top of the 2 meters. Use a cell phone to video each drop to accurately measure the drop distance traveled. This is the distance from the top of the 2-meter drop to where the head first hits (Refer to Figure 2). Record the data on the **Data Collection and Analysis Handout**. Conduct three trials for each rubber band added and average the results.

BUILD A BUNGEE DATA COLLECTION AND ANALYSIS

Please Note: *Make all measurements using meters.*

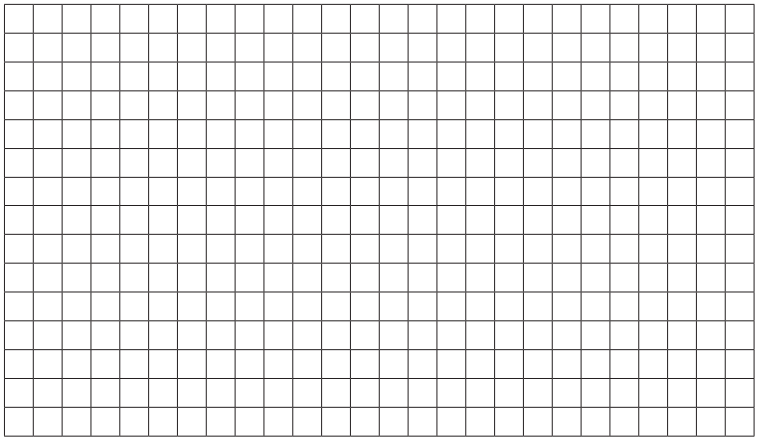
Number of Rubber Bands	Drop Distance Trial 1	Drop Distance Trial 2	Drop Distance Trial 3	Average Drop Distance (m)

Figure 2



BUILD A BUNGEE DATA COLLECTION AND ANALYSIS (CONT.)

1. Use the data gathered to graph a mathematical model of the averaged results. Remember to appropriately label each axis.



2. Connect the data points above using a best-fit line.

3. Write the linear equation in slope-intercept form (y = mx + b) that represents the best-fit line.

4. What does the x represent for this situation?

5. What does the y represent for this situation?

6. What does the slope represent for this situation?

7. What does the y-intercept (b) represent for this situation?

8. How many rubber bands did it take for your doll/action figure to have a “safe” jump?

9. How close was your prediction to the actual number of rubber bands that were required?

10. Write a conclusion statement about what was learned from this investigation.