# Middle School Investigation Using NCTM Illuminations

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To access the lessons seen in this presentation, visit **www.KatieAHendrickson.com** and click on the “Presentations” tab.

- Barbie Bungee (8.F.3, 8.EE.6, SMP.4, SMP.6)

- Equations of Attack (8.EE.6, SMP.2, SMP.3, SMP.4)

- Building Height (6.SP.3, 6.SP.5, SMP.3, SMP.6)

- Who Lost More? (7.RP.3, SMP.3)

Or you can visit **http://illuminations.nctm.org** for many other lessons and activities.

# Barbie Bungee

NAME ____________________________

In this activity, you will simulate a bungee jump using a Barbie® doll and rubber bands.

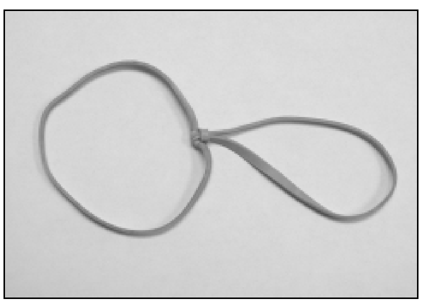
Before you conduct the experiment, formulate a conjecture:

> *I believe that _____ is the maximum number of rubber bands that will allow Barbie to safely jump from a height of 400 cm.*

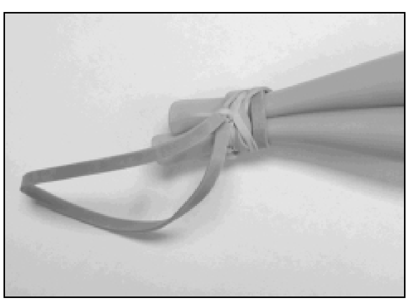
Now, conduct the experiment to test your conjecture.

PROCEDURE:
Complete each step below. As you complete each step, put a check mark in the box to the left.

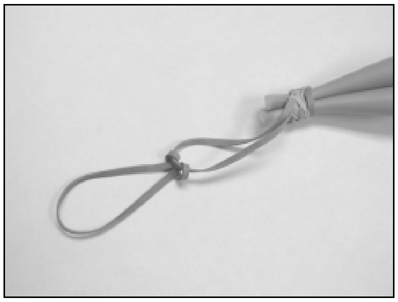
- ❑ Tape a large piece of paper to the wall from the floor to a height of about six feet.
- ❑ Draw a line near the top to indicate the height from which Barbie will make each jump.
- ❑ Create a double-loop to wrap around Barbie's feet. A double-loop is made by securing one rubber band to another with a slip knot, as shown (below left).



- ❑ Wrap the open end of the double-loop tightly around Barbie's feet, as shown (below right).



- Attach a second rubber band to the first one, again using a slip knot, as shown below.



- With two rubber bands now attached, hold the end of the rubber bands at the jump line with one hand, and drop Barbie from the line with the other hand. Have a partner make a mark to the lowest point that Barbie reaches on this jump.

- Measure the jump distance in centimeters, and record the value in the data table in Question 1. You may wish to repeat this jump several times and take the average, to ensure accuracy. Accuracy is important—Barbie's life could depend on it!

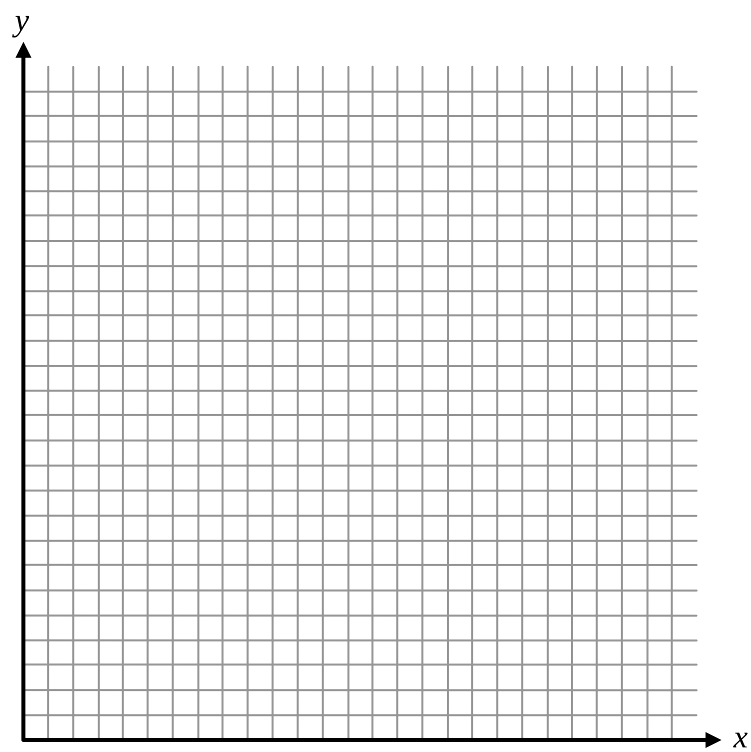
- Repeatedly attach two additional rubber bands for each new jump, measure the jump distance, and record the results in the data table.

- When you've completed the data table, answer Questions 2-12.

**1.** Complete the data table below.

| NUMBER OF RUBBER BANDS (*X*) | JUMP DISTANCE IN CENTIMETERS (*Y*) |
|---|---|
| 2 | |
| 4 | |
| 6 | |
| 8 | |
| 10 | |
| 12 | |

**2.** Make a scatterplot of your data. Indicate the scale on each axis.




**3.** On the graph above, sketch a line of best fit.

**4.** What is the relationship between the number of rubber bands and jump distance?

**5.** What is the equation for your line of best fit? (You may wish to use a graphing calculator for this part of the lesson. Enter the rubber band data in $L_1$, and enter the jump distance data for $L_2$.)

**6.** What is the slope of your equation, and what does it represent in this context?

**7.** What is the *y*-intercept of your equation, and what does it represent in this context?

**8.** Based on your data, what would you predict is the maximum number of rubber bands so that Barbie could still safely jump from 400 cm?

Using your Line of Best Fit: ________________________________

Using your Regression Equation: ____________________________

**9.** Are your predictions reliable? Justify your answer. Be sure to consider your methods of collecting, recording, and plotting data.

**10.** How do your predictions from Question 8 compare to the conjecture you made before doing the experiment? What prior knowledge did you have (or not have) that helped (or hindered) your ability to make a good conjecture?

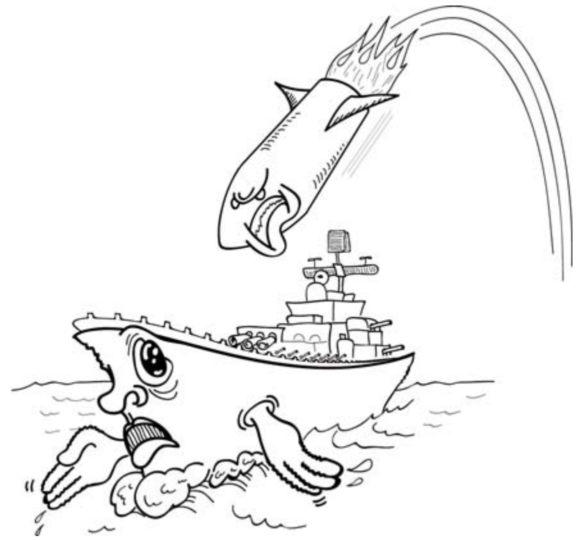
**11.** In what ways did you contribute to the group while working on this project?

**12.** Use the space below to list any additional comments.

# Equations of Attack

NAME ____________________________

## Questions



1. As you play the game, write equations for each of your lines that sunk your opponent's ships.

2. If you did not sink all of your opponent's ships, write equations that would sink the ships that are still afloat.

3. Explain the strategy you used for choosing your cannons. Do you think your strategy is the best possible strategy? Why?

4. Explain how you could tell that your equation would sink an enemy ship without graphing.

## Rules of the Game

1. Flip a coin to determine who gets to place the first ship and gets to choose whether he/she gets the even or odd cannons.

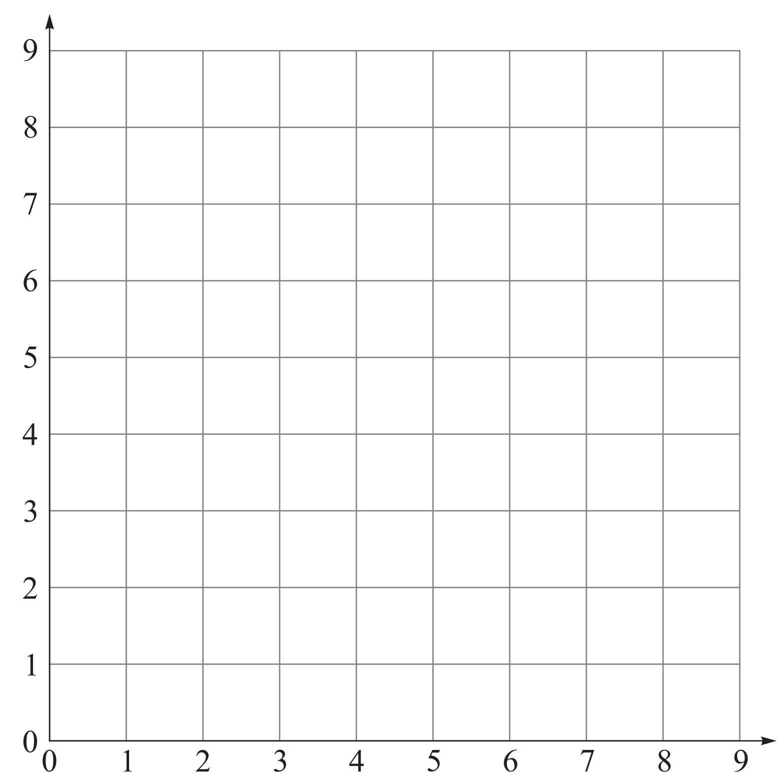
2. Each player should choose one color to represent his/her fleet. One player (decided by the coin toss) places the first ship by drawing a large dot on the board. Then, the other player places the second ship. Continue placing ships until each player has five ships on the board. **Note:** Ships can only be placed at lattice points (where both the *x*- and *y*-coordinates are integers). For example, you can place a ship at $(4, 5)$, but you can't place a ship at $(4.5, 5)$ or $(4, 5\frac{1}{3})$. Also, ships cannot be placed along the *y*-axis.

3. Each player will have five cannons along the *y*-axis. One player will have all the even cannons (0, 2, 4, 6, 8), and the other player will have the odd cannons (1, 3, 5, 7, 9), as determined by the initial coin toss. Mark your cannons with X's using your color.

4. It's time to play! The player with the even cannons goes first. Draw a slope card from the face-down deck. Choose any of your five cannons to shoot from. Draw a line from the cannon you chose in the direction determined by your slope. If you hit an opponent ship (or more than one), the ship is sunk!

5. Play alternates until all of one player's ships are sunk. The first player to sink all opponent ships is the winner!

## Game Board



## Slope Cards

NAME____________________________

Cut out these cards and stack them face down for your game of Equations of Attack.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | $-\frac{2}{5}$ |
| –1 | –2 | –3 | –4 | –5 | $-\frac{1}{3}$ |
| $\frac{1}{2}$ | $\frac{3}{2}$ | $\frac{5}{2}$ | $\frac{1}{3}$ | $\frac{2}{3}$ | $-\frac{1}{4}$ |
| $\frac{4}{3}$ | $\frac{5}{3}$ | $\frac{1}{4}$ | $\frac{3}{4}$ | $\frac{5}{4}$ | $-\frac{1}{5}$ |
| $\frac{1}{5}$ | $\frac{2}{5}$ | $\frac{3}{5}$ | $\frac{4}{5}$ | $-\frac{1}{2}$ | $\frac{1}{5}$ |
| $-\frac{3}{2}$ | $-\frac{5}{2}$ | $-\frac{1}{3}$ | $-\frac{2}{3}$ | $-\frac{4}{3}$ | $\frac{1}{4}$ |
| $-\frac{5}{3}$ | $-\frac{1}{4}$ | $-\frac{3}{4}$ | $-\frac{5}{4}$ | $-\frac{1}{5}$ | $\frac{1}{3}$ |
| $-\frac{2}{5}$ | $-\frac{3}{5}$ | $-\frac{4}{5}$ | 0 | 0 | $\frac{2}{5}$ |

# Building Height

NAME ____________________________

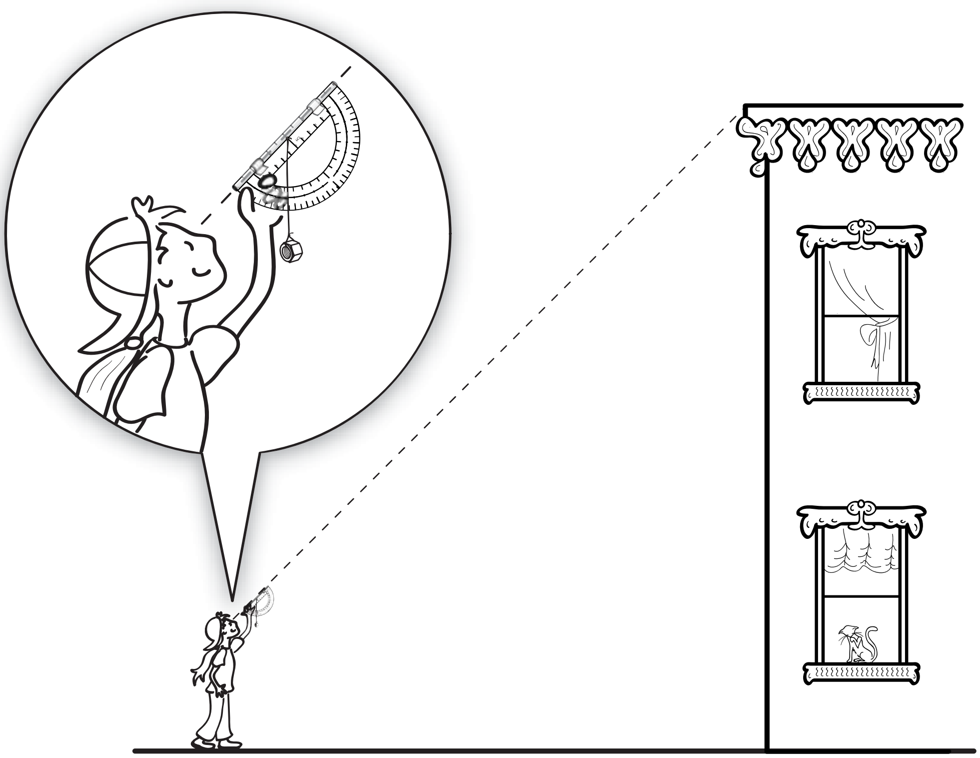
**1.** Choose which partner will be the measurer and which will be the helper. Complete the table by first measuring accurately according to the instructions, and then recording your results.

| EYE-LEVEL HEIGHT (IN INCHES) | DISTANCE FROM BUILDING (IN INCHES) | HEIGHT OF BUILDING (IN INCHES) | HEIGHT OF BUILDING (IN FEET) |
|---|---|---|---|
| | | | |

**Eye-Level Height**
Use the tape measure to measure the height from the eyes of the measurer to the ground. This measurement should be rounded to the nearest inch.

**Distance from Building**

1. The measurer should hold the clinometer so that the highest point of the building to be measured is visible through the straw.
2. The helper should now instruct the measurer to move backward or forward, until the angle measurement on the clinometers reads 45°. The measurer should make sure to keep the top of the building in sight through the straw while moving.
3. Measure the distance on the ground between the measurer and the building, in inches.



**Height of Building**
Add eye-level height to the distance-from-building measurement. Record this measurement in the third column of the table. Then convert the measurement to feet, and record this in the last column.

**2.** Collect data from the class and record it on the table below. Don't forget to include your data from the first page.

| PAIR | HEIGHT OF BUILDING (IN FEET) |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**3.** Using the data in the table above, find the mean, median, and mode of the building height measurements.

Mean:

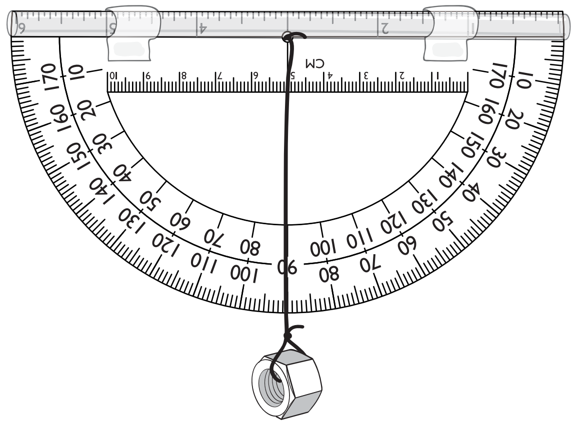
Median:

Mode:

**4.** Select one measure of central tendency to report as the building height. Which measure did you choose? Why does this measurement most accurately represent the "average" of the data?

**5.** Do you think the result is accurate? How could you improve the accuracy of this method of measurement?

# Clinometer Construction



1. Tie one end of the string to the weight.
2. Tie the other end of the string to the center hole in the base of the protractor. Make sure the knot lines up with the center hole and not the outside or inside of the protractor.
3. Tape the drinking straw to the flat edge of the protractor. Make sure the ends of the straw lie flush with the corners of the protractor.
4. Turn the protractor upside down. The weight should pull down the string so that it passes through the degree measures when the clinometer is turned.

# Who Lost More?

NAME________________________

The following chart lists participants from an episode of *The Biggest Loser* with their starting weights and their weight at the end of the episode.

| PARTICIPANT | STARTING WEIGHT | WEIGHT AT THE END OF THE EPISODE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**1.** Who has lost the most weight? Explain.

**2.** What method will your group use to compute weight loss? Why did you choose this method?

**3.** Which method did the *The Biggest Loser* use to compare weight loss?

**4.** Record each participant's weight loss below.

| PARTICIPANT NAME | YOUR METHOD | PERCENT DECREASE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**5.** Circle the contestant who lost the most according to your method.

**6.** Box the contestant who lost the most according to percent decrease.

**7.** Which method of calculating weight loss is the fairest? Explain.