Engineering Design Challenge:

To Create a Safe Bungee Cord for Washy

↗ Meet Washy!
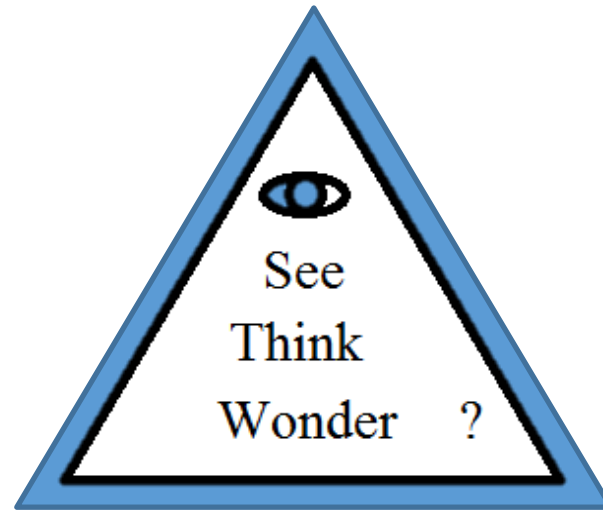
Story Time: Crazy Town

- Listen to the teacher's story
- Watch a five-minute video on bungee jumping:

  https://www.youtube.com/watch?v=RoLjKlHYvzA

During the video, record the following:

1. What do you SEE?
2. What do you THINK about that?
3. What does it make you WONDER?

Define: Force

Force is a push or a pull on an object.

- It results from one object's interaction with another object.

- Unless it is opposed, a force changes the motion of an object.
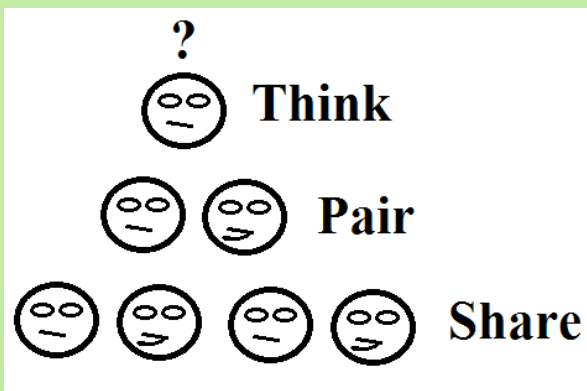
Brainstorming & Discussion

- Turn and talk to a partner: *Ideas?*
- Class discussion

Story Time: Crazy Town

Issue: How does the bungee cord length impact the distance of the bungee jump fall?

- How does this concept relate to force?

THINK: Write down the following:
Do you think that the cord length is an issue to consider when designing a ride for Crazy Town?
Explain in writing why or why not

PAIR: Now pair up with another student and discuss your thoughts on this issue.

SHARE: What are some your ideas about bungee cord length?
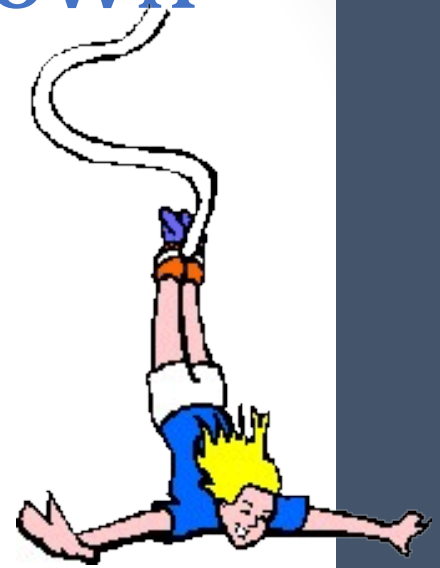
Create a Safe Bungee Cord for Washy!

Notes

I'm Washy! ↗

Activity Objectives: Write Down

- The executives want you to *infer* and *measure* the *falling* distance for different bungee lengths (This is called displacement)

- This ride should be thrilling, yet safe

- Find the maximum length of the cord to get as close to the ground without a splat

Activity Objectives: Write Down

Use this information to *find the force* of the bungee jumping
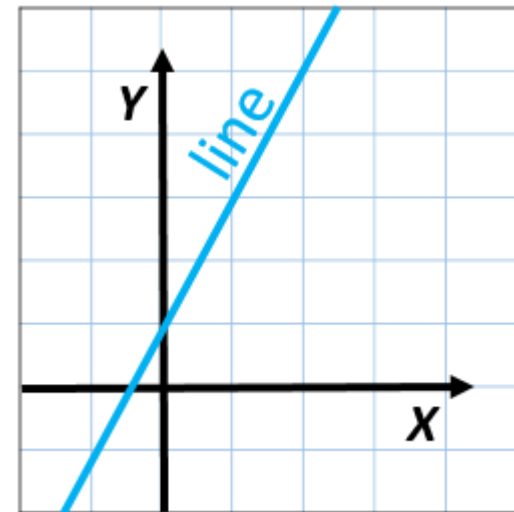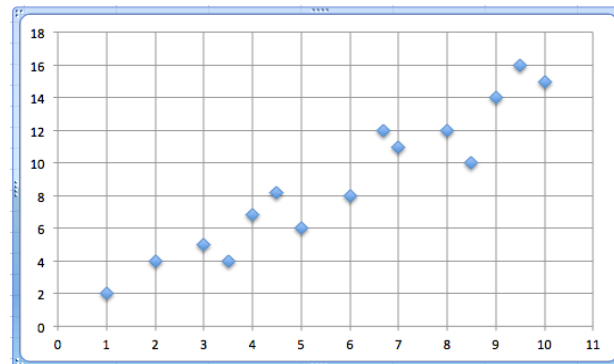
Displacement = ???

Force = ???

Activity Objectives: Write Down

- Use an equation called *Hooke's law* to calculate the spring constant (k)

- Also use *scatter plots* and *linear equations* to predict the maximum length of the bungee cord for a safe fall and return

Activity Objectives

1. Answer the following questions about the objectives:
    - What do you know?
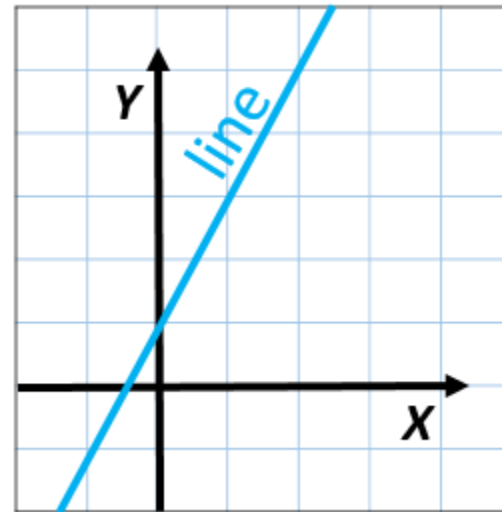   - What do you want to know?
2. Then turn and talk to a partner about what you just wrote

Quick Notes & Discussion

Reviewing terms

A linear equation is the equation for a straight line

Example linear equation: y= 2x + 1

Quick Notes and Discussion

Reviewing terms

A linear equation is the equation for a straight line

An example of a linear equation is y= 2x + 1

Example: $Y = 2x + 1$
$$1 = 2(0) + 1 \text{ when x is 0, y is 1}$$
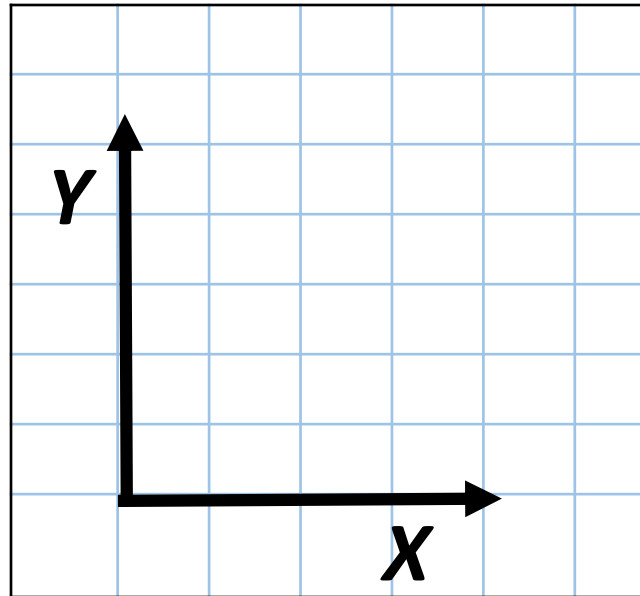$$3 = 2(1) + 1 \text{ when x is 1, y is 3}$$
$$5 = 2(2) + 1 \text{ when x is 2, y is 5}$$

Quick Notes & Discussion

New term: scatter plot

- A graph of plotted points

- Uses the same axes to plot data as line graphs

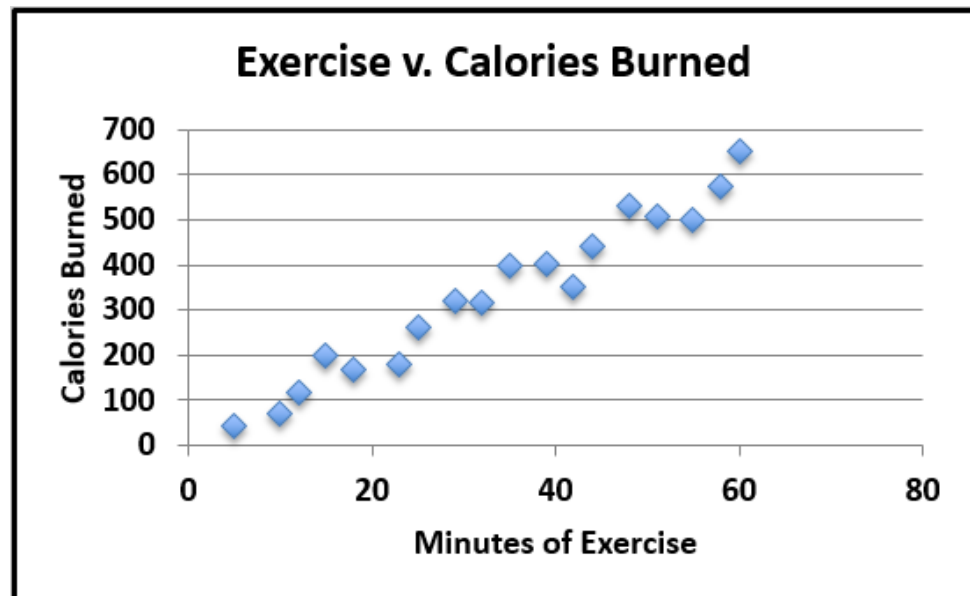- Shows the relationship (also called correlation) between the variables

Quick Notes & Discussion

New term: positive correlation

- When your data plots similar to a line going up from left to right

- As x-values increase, y-values increase

- A positive slope

*Example*: The more you exercise, the more calories you burn.

Exercise v. Calories Burned

Quick Notes & Discussion

New term: negative correlation

- When your data plots similar to a line going down from left to right
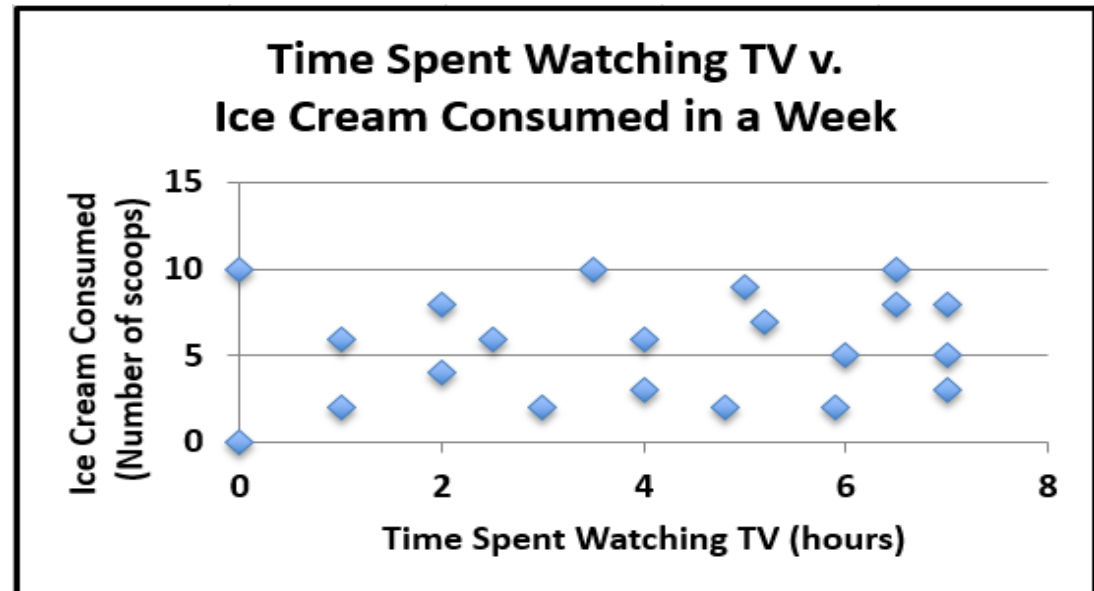- As x-values increase, y-values decrease
- A negative slope

Example: As the bikers' speed increases, the amount of time to the finish line decreases.

Speed of Biker v. Time to Finish Line
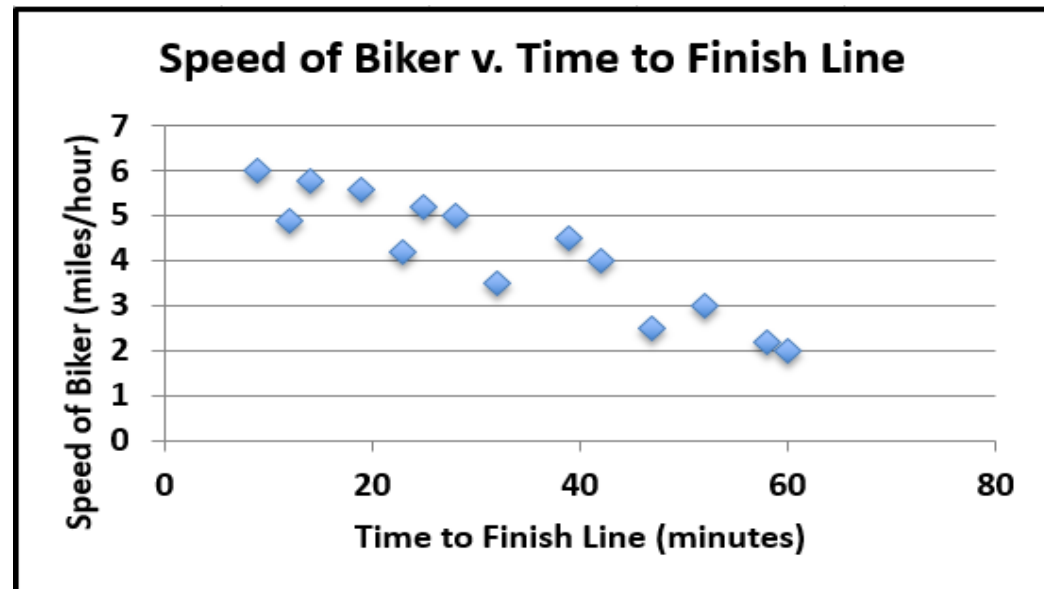
Quick Notes & Discussion

New term: no correlation

- When the data points are all over the graph and no relationship exists
- No pattern exists in the points in the graph

Example: The amount of hours you watch TV in a week and the number of scoops of ice cream you eat in a week.

**Time Spent Watching TV v.
Ice Cream Consumed in a Week**

Ice Cream Consumed
(Number of scoops)

Time Spent Watching TV (hours)

Quick Notes & Discussion
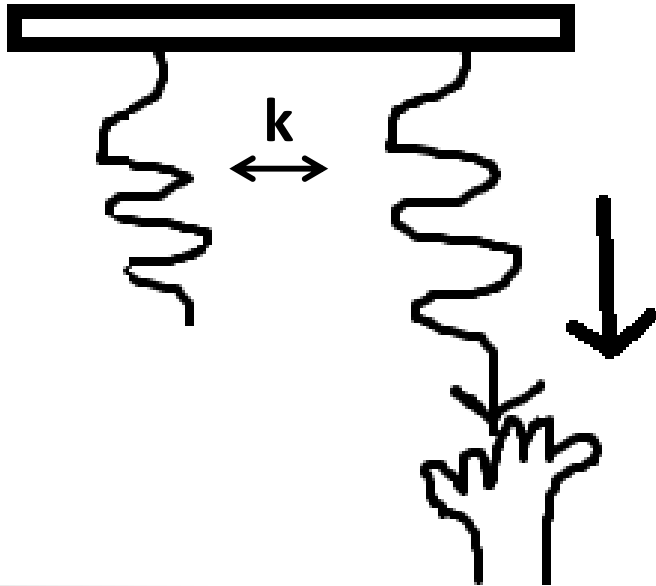
Correlation does not imply causation!

Just because a strong correlation or relationship exists between two variables, does not mean one caused the other!
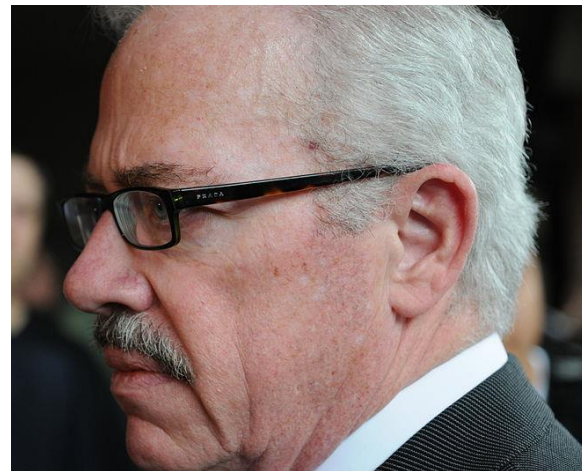
Quick Notes & Discussion

Hooke's law:

The force of an elastic object (spring), is directly related to how far the spring is stretched (displacement)

k

If you exert more force, the spring will have more elastic force

Quick Notes & Discussion

The equation for Hooke's law is **F = -kx**

   F = spring force (N)

   k = spring constant (N/m)

   x = length of the displacement for the spring (m)

- k, the spring constant, represents how rigid the spring is: a high k spring = a highly rigid spring
- When pulling a spring, k is negative (-k)
- When pushing a spring, k is positive (k)

Quick Notes & Discussion
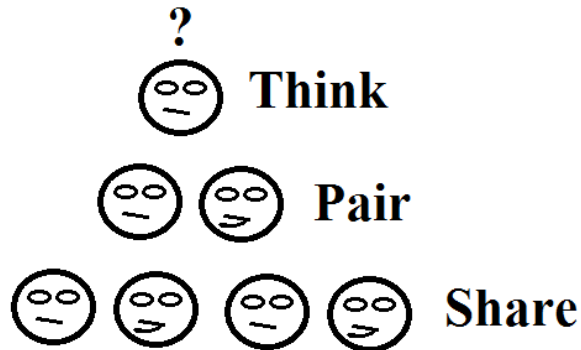
Tension vs. overextension

- Tension (pulling) leads to a more rigid elasticity of the spring

- Extension can lead to distortion of the string

distortion
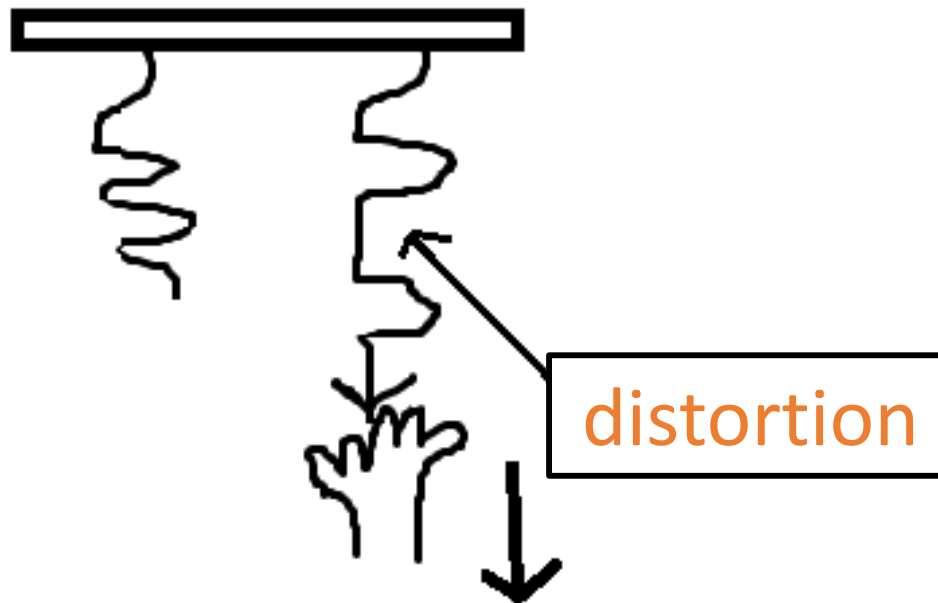
Think – Pair – Share

- Take 2½ minutes to look over your notes
- Take 2½ minutes to share what you learned with a partner
- Class discussion on what you learned

Create a Safe Bungee Cord for Washy!

Discussion

Hi, Washy! ↗

Scatter Plot for Table 1

1. What type of a correlation does your data represent between the number of rubber bands and displacement (jump distance)?

2. Why do you think this type of correlation is present?

Slope and Equation of a Line

1. Calculate the slope of the line of best fit.

$$\text{Slope} = m = \frac{rise}{run} = \frac{y_2 - y_1}{x_2 - x_1}$$

2. Determine the equation of the line of best fit using y = mx + b.

3. What does the slope represent in this context?

4. What is the y-intercept for your line of best fit?

5. What does the y-intercept represent in this context?

Interpreting Data

1. Based on your data, what was the maximum number of rubber bands that enabled Washy to bungee jump safely? What was the maximum displacement?

2. Compare your result to your hypothesis. What prior knowledge did you have, or not have, that guided, or hindered, your ability to make a good hypothesis?

3. Based on your line of best fit, predict the maximum number of rubber bands that would enable Washy to bungee jump safely from a height of 300 cm. Show your work.

Interpreting Data

4. Are your predictions reliable? As you justify your answer, consider the methods used to collect, record and plot data.

5. Do you think the type and/or width of the rubber band affects the results? How would it?

6. Do you think age of the rubber bands affects the results? That is, what would happen if old rubber bands were used?

Scatter Plot for Table 2

1. What type of a correlation does your data represent between displacement and the absolute value of the spring constant?

2. Why do you think this type of correlation is present? (Note: Consider Hooke's law and the fact that the force did not change in the experiment .)