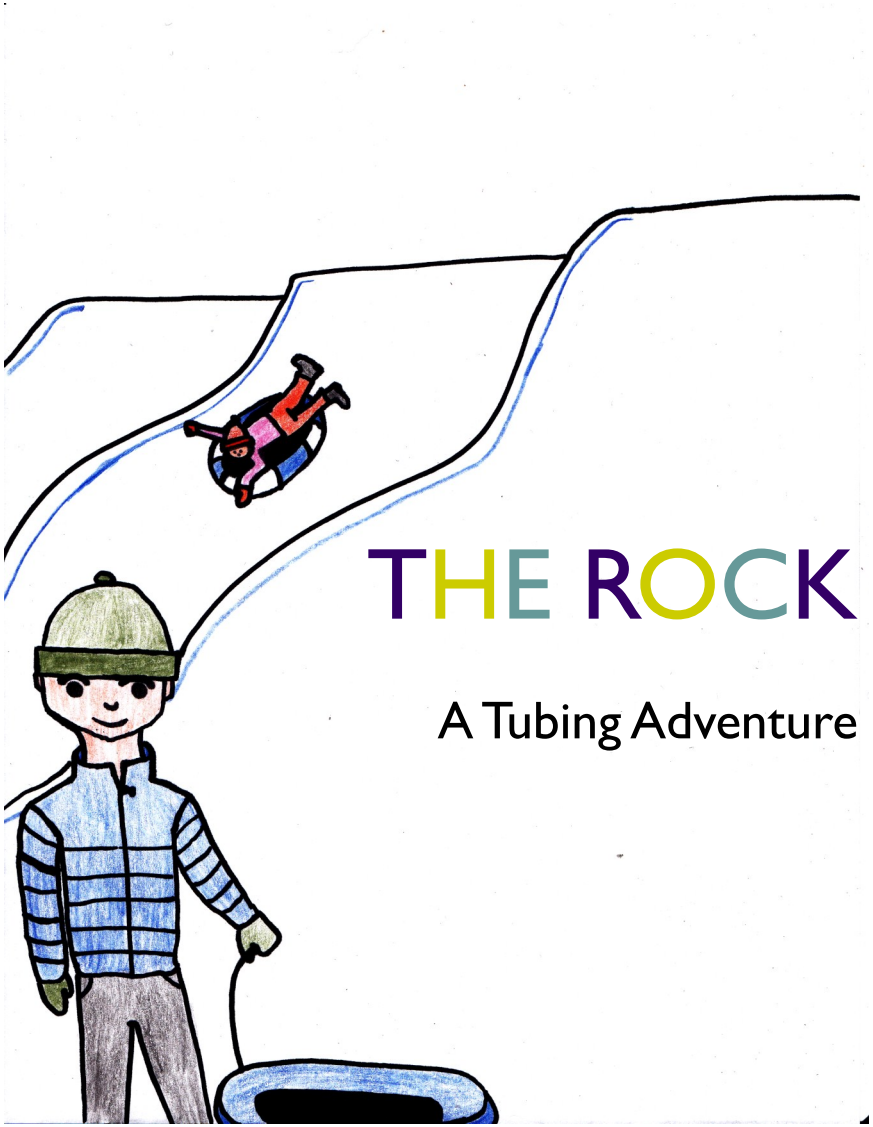
# Thanks for Visiting The Rock

## Student Work Book

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# Introduction

Welcome to The Rock! During your tubing adventure there will be three guides who need YOUR help to find some answers.

*Bold vocabulary definitions can be found in the glossary.*

**Cam (Section 1)**

***Learning Target 1:*** I can find the average speed of three different riders/ tubers.

***Learning Target 2:*** I can create a scatter plot for the whole class comparing mass and speed.

**Sam (Section 2)**

***Learning Target 1:*** I can find the acceleration of three different riders/tubers.

***Learning Target 2:*** I can create a scatter plot for the whole class comparing mass and acceleration.

**Alex (Section 3)**

***Learning Target 1:*** I can find the kinetic and potential energy of three different riders/ tubers.

***Learning Target 2:*** I can determine the work done by the tow rope for three different riders/ tubers.

***Learning Target 3:*** I can create a scatter plot comparing energy with work for the whole class.



***Gravitational Potential Energy:*** is the influence of gravity on an object, and is usually measured in Joules (J). Gravitational potential energy is the product of mass, acceleration due to gravity and height.

$$PE = m * g * h$$

***Kinetic Energy:*** is energy in motion and is usually measured in Joules (J).

$$KE = 1/2 * m * v^2$$

***Mass:*** is the product of density and volume and is usually measured in kilograms (kg).

***Potential Energy:*** is stored energy and is usually measured in Joules (J).

***Speed:*** is the change in distance over time and is usually measured in meters per second (m/s).

$$s = d/t$$

***Work:*** is the product of force (F) and distance (d) and is usually measured in Joules (J).

$$W = F * d$$

# Glossary/Equations

***Acceleration:*** is defined as change in velocity (or speed) over time. It is usually measured in meters per second squared ($m/s^2$).

$$a = (v_2-v_1)/t$$

***Acceleration Due to Gravity:*** $g = 9.81\ m/s^2$

***Average Acceleration:*** is found by adding multiple acceleration quantities and dividing by the number of them.

***Average Speed:*** is found by adding multiple speed quantities and dividing by the number of them.

***Force:*** is the product of acceleration ($m/s^2$) and mass (kg) and is usually measured in Joules (J).

$$F = a * m$$



# Table of Contents

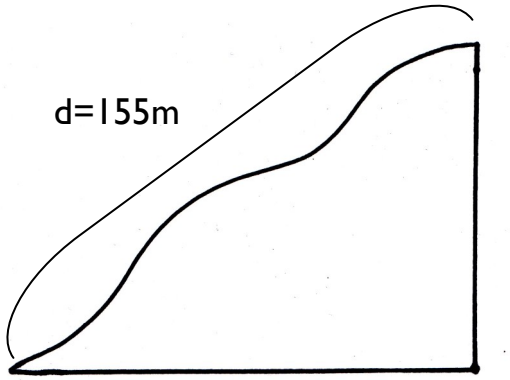
# Section 1: Cam

Background Knowledge:

Hello, my name is Cam and I need your help to find the average speed as you slide down the hill. Speed is the change in distance over time it takes to reach a certain distance. It is usually measured in meters per second. In this activity, you will be finding the average speed of at least three riders.

To do this, you will:

1. Find the **mass** of each rider and tube in kilograms.
2. Use a stopwatch to time how long it takes each rider to get from the top of the hill to the bottom. (Take two trials.)
3. Calculate the **speed** for each trial.
4. Calculate the **average speed** for each rider.



Notes/ Work Space



**Mass:**

(convert weight(lb) to mass(kg), add 4.54 kg )

Rider 1: Name_____

_____ lb. * 0.454= _____kg + 4.54 kg

= _____kg. (total)

Rider 2: Name_____

_____ lb. * 0.454= _____kg + 4.54 kg

= _____kg. (total)

Rider 3: Name_____

_____ lb. * 0.454= _____kg + 4.54 kg

= _____kg. (total)

1. Who do you think will go the fastest, and why?

2. Do you think mass affects speed? How?

**Speed:**

Speed= d/t  d= 155m

Average Speed= $(s_1 + s_2)/2$

Rider 1: Name_____

$time_1$: _____sec  $time_2$: _____sec

speed $_1$:_____sec  speed $_2$:_____sec

average speed: _____m/s

Rider 2: Name_____

$time_1$: _____sec  $time_2$: _____sec

speed $_1$:_____sec  speed $_2$:_____sec

average speed: _____m/s

Rider 3: Name_____

$time_1$: _____sec  $time_2$: _____sec

speed $_1$:_____sec  speed $_2$:_____sec

average speed: _____m/s



1. Who had the greatest potential energy? Were you right? Explain.

2. Who had the greatest kinetic energy? Were you right? Explain.

3. Who had the greatest work? Were you right? Explain.

**Graphing:**

Create a scatter plot comparing the energy with work for the **whole class** (Use different symbols for each energy/work.)

1. Which rider do you think will have the most potential energy, kinetic energy, or work?

2. Do you think mass affects potential energy, kinetic energy, or work?

**Potential Energy (PE):**

PE= mgh

(mass * acceleration due to gravity * height of hill)

Rider 1: _____ * _____ * _____=_____ J

Rider 2: _____ * _____ * _____=_____ J

Rider 2: _____ * _____ * _____=_____ J

**Kinetic Energy (KE):**

KE= 1/2 $mv^2$ (1/2 * mass * $velocity^2$)

Rider 1: 1/2 * _____ * (_____)$^2$= _____ J

Rider 2: 1/2 * _____ * (_____)$^2$= _____ J

Rider 3: 1/2 * _____ * (_____)$^2$= _____ J

**Work (W): done by the tow rope on each rider**

W=Fd (Force * distance)

Rider 1: _____ * _____= _____ J

Rider 2: _____ * _____= _____ J

Rider 3: _____ * _____= _____ J

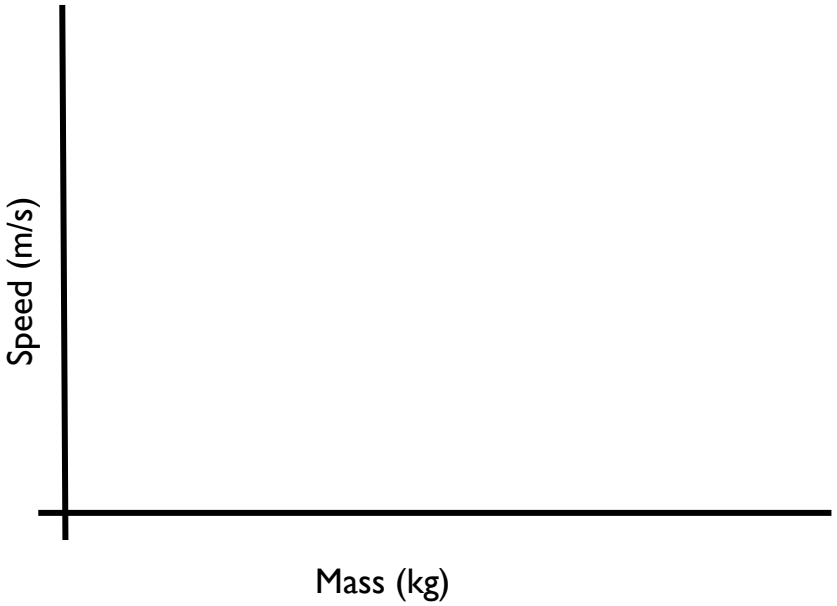


1. Who went the fastest? Were you right? Explain.

2. Why do you think he/she went the fastest? Explain.

**Graphing:**

Create a scatter plot comparing the mass and speed for the **whole class**. Include appropriate title.

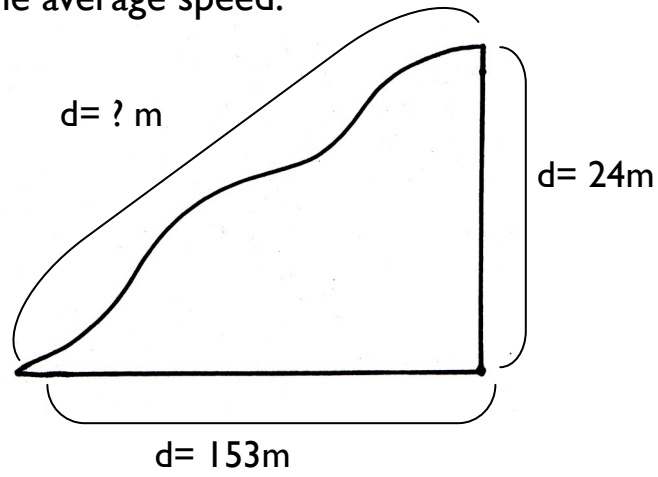


# Section 2 (Sam)

Background Knowledge:

Hello, my name is Sam and I need your help to find the acceleration as you slide down the hill. Acceleration is defined as change in velocity (or speed) over time. It is usually measured in meters per second squared ($m/s^2$). In this activity you will calculate the average acceleration for 3 different riders. To do this you will:

1. Find the **mass** of each rider.
2. Calculate the mass of a tube.
3. Find the **average speed** for each rider (take at least two trials).
4. Calculate the **acceleration** for each rider using the average speed.





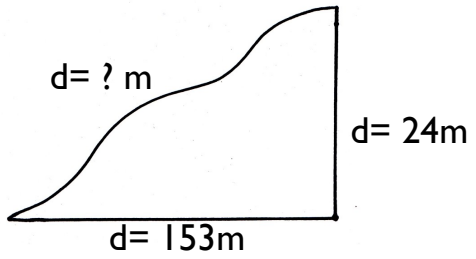

**Mass:**

(To convert pounds to kilograms multiply by 0.454, and do not forget to add the mass of the tube!)

Rider 1: _____kg

Rider 2: _____kg

Rider 3: _____kg




**Speed:** (round distance to the nearest ones place.)

Rider 1- average speed: _____m/s

(Trial 1:_____m/s Trial 2:_____m/s)

Rider 2- average speed: _____m/s

(Trial 1:_____m/s Trial 2:_____m/s)

Rider 3- average speed: _____m/s

(Trial 1:_____m/s Trial 2:_____m/s)

**Acceleration:**

Rider 1- average acceleration: _____$m/s^2$

(Trial 1:_____$m/s^2$ Trial 2:_____$m/s^2$)

Rider 2- average acceleration: _____$m/s^2$

(Trial 1:_____$m/s^2$ Trial 2:_____$m/s^2$)

Rider 3- average acceleration: _____$m/s^2$

(Trial 1:_____$m/s^2$ Trial 2:_____$m/s^2$)

# Section 3 (Alex)

Background Knowledge:

Hello, my name is Alex and I need your help to find the potential energy before you slide down the hill, the kinetic energy as you slide, and the amount of work it takes to get back to the top of the hill. One type of potential, or stored, energy is gravitational potential energy which measures the influence of gravity on an object, and is usually measured in Joules (J). Kinetic energy is energy in motion and is also measured in Joules (J). Work is the product of force (F) and distance (d), and is measured in Joules (J) as well. In this activity you will find the potential and kinetic energy for three different riders, and the work done by the tow-rope pulling the tubes up the hill. To complete these tasks you will:

1. Find the **mass** of each rider *and* tube.
2. Find the **average speed** of each rider (take at least two trials).
3. Find the **average acceleration** of each rider (take at least two trials).
4. Calculate the **potential energy** for each rider.
5. Calculate the **kinetic energy** for each rider.
6. Calculate the **work** done by the tow rope.

*Rider 1: Name*_____

*Rider 2: Name*_____

*Rider 3: Name*_____



**Mass:**

(convert weight(lb) to mass(kg), add tube mass(kg)

Rider 1: Name_____

_____ lb. * 0.454= _____kg + _____kg

= _____kg. (total)

Rider 2: Name_____

_____ lb. * 0.454= _____kg + _____kg

= _____kg. (total)

Rider 3: Name_____

_____ lb. * 0.454= _____kg + _____kg

= _____kg. (total)

**Speed: (**round to the nearest ones place for distance)

Rider 1- average speed: _____m/s

(Trial 1:_____m/s Trial 2:_____m/s)

Rider 2- average speed: _____m/s

(Trial 1:_____m/s Trial 2:_____m/s)

Rider 3- average speed: _____m/s

(Trial 1:_____m/s Trial 2:_____m/s)

1. Who do you think will have faster acceleration? Why?

2. Do you think mass will affect acceleration? Why?

## Acceleration:

$a = (s_2 - s_1)/ t$

(speed at bottom of hill - speed at top of hill)/ seconds$^2$

Rider 1: (_____ - _____) / _____

= _____m/s$^2$

Rider 2: (_____ - _____) / _____

= _____m/s$^2$

Rider 3: (_____ - _____) / _____

= _____m/s$^2$

1. Who had the fastest acceleration? Were you right? Explain.

2. Did the mass affect acceleration? Explain.



## Graphing:

Create a scatter plot comparing the mass and acceleration for the **whole class**. (Don't forget to label all the parts of the graph.)