Stopping Distance vs Maximum Speed Lab

• Hot Wheels track or ramp
• Hot Wheels car
• Meter stick or measuring tape
• Masking tape

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When a car rolls down a ramp, gravitational potential energy converts into kinetic energy. Where:

- g= gravitational acceleration (9.8 m/s²)
- h= vertical height of the ramp in meters.
- v= speed at the bottom of the ramp

This means we can **calculate the maximum speed using the vertical release height**. Speed is found by: $v = \sqrt{2gh}$

Procedure

1. Place one end of the Hot Wheels track on the floor.
2. Raise the other end using books to create a ramp.
3. Measure the **vertical release height** $h$from the starting point to the floor.
4. Release the car **without pushing it**.
5. Measure the **stopping distance on the floor** from the end of the ramp.
6. Repeat the experiment for several different heights.

Height (m)	**Calculated Speed (m/s)**	**Stopping Distance (cm)**
0.10 m		
0.25 m		
0.45 m		
0.70 m		
1m		

Analysis

Sketch the general shape of your graph.

How does stopping distance change as speed increases?

Identify the vertex (h, k).

Identify one additional point (x, y).

Determine the value of **a** for the quadratic model $y = a(x - h)^2 + k$

Describe the transformations required to create the best-fit function.

Explain why stopping distance increases rapidly at higher speeds.

Free-Fall Motion Experiment

Objective: Investigate how the time it takes for an object to fall relates to the distance it falls and express this relationship using a radical function.

Materials:

- Meter stick
- Stopwatch
- Small ball

Procedure:

1. Hold a small ball at a height.
2. Drop the ball and measure the time it takes to reach the ground.
3. Repeat for different heights.
4. Record your measurements in a data table.
5. Plot the data on a graph with height on the horizontal axis and time on the vertical axis.
6. Determine the best-fit function that describes the relationship.

Height (cm)	Time (s)

Analysis

Sketch the general shape of your graph.

How does the fall time change as height increases?

Identify the value of the vertex (h, k).

Identify the value of any other data point (x, y).

Determine the value of a for the data using $y = a\sqrt{x-p}+q$.

Describe each of the transformations (translations, stretches, reflections) that are required to create the best-fit function.

How would the graph change if the object had more air resistance?

Period of a Pendulum vs. Pendulum Length

Materials:

- Thread
- Mass
- Tape
- Ruler
- Timer

Objective: Investigate how the period of a pendulum depends on its length and express this relationship using a radical function.

Procedure:

1. Tie a length of thread to a mass so that the pendulum length is 50 cm.

2. Pull the mass to one side and allow it to swing freely.

3. Measure the total time for 5 complete swings back and forth.

4. Calculate the time for one swing (period).

5. Repeat steps using lengths of 50 cm, 40 cm, 30 cm, 20 cm, 10 cm, 5 cm, and 3 cm.

6. Use desmos.com to create a function that describes the period of a pendulum vs. its length:

Pendulum Length (cm)	Time for 5 Swings (s)	Period (s) Time for 1 Swing (s)
50		
40		
30		
20		
10		
5		
3		

Analysis

Sketch the general shape of your graph.

How does the period change as the pendulum length increases?

Identify the value of the vertex (h, k).

Identify the value of any other data point (x, y).

Determine the value of a for the data using $y = a\sqrt{x-p}+q$.

Describe each of the transformations (translations, stretches, reflections) that are required to create the best-fit function.

How would the graph change if the mass of the pendulum were doubled?

Water Drainage from a Container

Objective: Investigate how the height of water in a container decreases over time as it drains and express this relationship using a radical function.

Materials:

- Plastic bottle (with a small hole near the bottom)
- Water
- Stopwatch
- Ruler
- Marker

Procedure:

1. Find a plastic bottle with water to a marked height (e.g., 20 cm).
2. Open a small 3 mm hole using a sharp pencil or scissors at the bottom of the plastic bottle.
3. Fill the bottle to the marked height
4. Start the stopwatch and start draining the water. Drain for 10 seconds and then plug the hole with your finger.
5. Measure the water height at specific time intervals (e.g., every 10 seconds).

Time (s)	Water Height (cm)
0	
10	
20	
30	
40	
50	
60	
70	

Analysis

Sketch the general shape of your graph.

How does the water height change as time increases?

Identify the value of the vertex (h, k).

Identify the value of any other data point (x, y).

Determine the value of a for the data using $y = a\sqrt{x-p} + q$.

Describe each of the transformations (translations, stretches, reflections) that are required to create the best-fit function.

How would the graph change if the hole at the bottom of the container were larger?

Light Intensity vs. Distance Lab

Objective: To investigate the relationship between light intensity and distance from a light source and express this relationship as a transformation of the parent function .

Materials:

- Light (small light source like a phone light, candle, or flash)
- Light sensor (phone app with a lux meter)
- Ruler or measuring tape
- Data table
- Graphing software

Procedure:

1. Place the flashlight on a flat surface in a dark room (This lab is best completed with the lights off).

2. Use the light sensor to measure intensity at different distances from the source (e.g., 5 cm, 10 cm, 15 cm, 20 cm, 25 cm, etc.).

3. Record the intensity in the data table.

4. Plot the data on a graph with distance on the horizontal axis and intensity on the vertical axis.

Distance (cm)	Light Intensity (lux)
10	
20	
30	
40	
50	
60	

Analysis

Sketch the general shape of your graph.

How does the water height change as time increases?

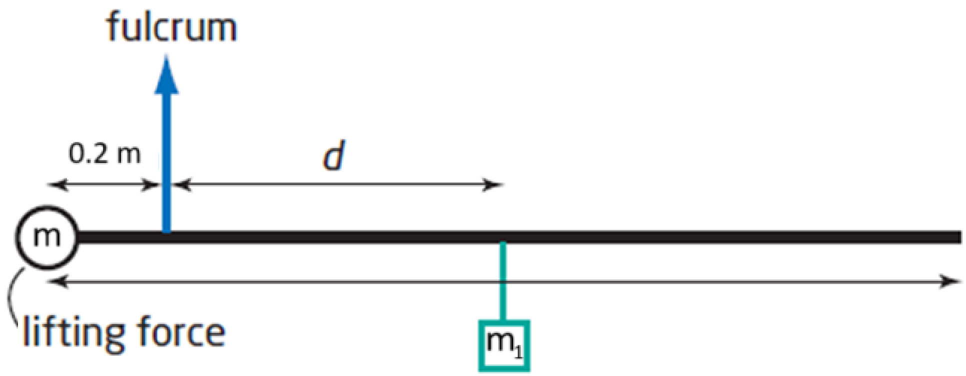
Identify the value of the vertex (h, k).

Identify the value of any other data point (x, y).

Determine the value of a for the data using $y = a\frac{1}{\sqrt{x-p}} + q$..

Describe each of the transformations (translations, stretches, reflections) that are required to create the best-fit function.

How would the graph change if the flashlight's brightness were doubled?



Maximum Mass vs Distance from Lifting Force

Objective: Investigate how the maximum mass that can be lifted depends on the distance from the lifting force and express this relationship using a function.

Procedure:

1. Use a mass, m, as the lifting force precisely 0.2 m from the fulcrum.
2. Balance the lifting force with a mass, x.
3. Record the distance from the fulcrum required to balance the lifting force.
4. Record the mass, m_1.
5. Repeat the steps using different masses.
6. Use desmos.com to create a function that describes the balanced mass vs. balanced distance.

Distance from Lifting Force (cm)	Mass (kg)

Analysis

Sketch the general shape of your graph.

How does the mass required to balance the system change as the distance increases?

Identify the value of the vertex (h, k).

Identify the value of any other data point (x, y).

Determine the value of a for the data using $y = \frac{a}{x-p} + q$..

Describe each of the transformations (translations, stretches, reflections) that are required to create the best-fit function.

Use your function to calculate the distance required to balance the lifting force using a mass of 5 kg,