

Newton's 2<sup>nd</sup> Law

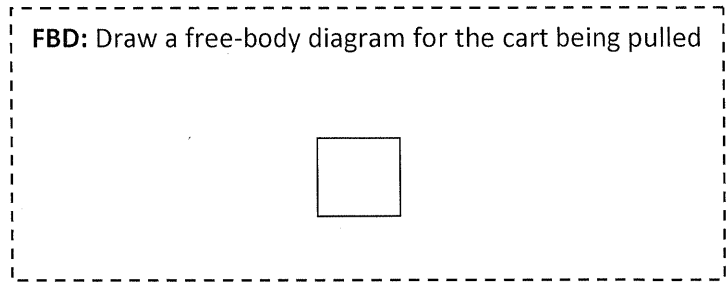
Cart Race

FBD: Draw a free-body diagram for the cart being pulled

Purpose: To determine the relationships between acceleration, force and mass.

Materials: cart, timer, measuring tape, graph paper

Procedure: Take a person on the cart. Pull them 5 separate times. Use the formula below to calculate the acceleration of the ride and then use that information to find the  $F_{net}$ . Also in this area draw a diagram of what the procedure is.



Data:

Rider 1: \_\_\_\_\_  
 Mass (cart + rider): \_\_\_\_\_ kg  
 Distance: \_\_\_\_\_ m

Rider 2: \_\_\_\_\_  
 Mass (cart + rider): \_\_\_\_\_ kg  
 Distance: \_\_\_\_\_ m

Force (N)	Time (s)	Acceleration ( $a = 2d/t^2$ ) ( $m/s^2$ )

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Discussion:

- 1) Plot a graph of **Force vs. Acceleration** for Rider 1. Draw a line of best fit and determine the slope and y-intercept (include units). Do all your work on the graph paper.
- 2) On the same axis plot a graph of F vs. a for Rider 2. Draw a line of best fit and determine the slope and y-intercept (include units).
- 3) Analyze your results and determine the relationship between force and acceleration.
- 4) Analyze your results and determine the relationship between acceleration and mass.
- 5) Should the lines you plotted go through (0,0)? Explain.
- 6) The relationship between force and acceleration is given by Newton's 2<sup>nd</sup> Law:  **$F_{net} = ma$** . In this case this becomes:

$$F_{app} - F_f = ma.$$

a. Rearrange this formula to fit the equation of a straight line:

$$y = mx + b$$

- b. What does the y-intercept represent?
- c. What does the slope represent?

Name:  
Block:

	Beginning	Developing	Accomplished	Exemplary
Free Body Diagram	<ul style="list-style-type: none"> <li>o Diagram is missing forces</li> <li>o Forces are not labelled</li> </ul>			<ul style="list-style-type: none"> <li>o Diagram includes all appropriate forces</li> <li>o Forces are labelled</li> </ul>
Procedure	<ul style="list-style-type: none"> <li>o No diagrams</li> </ul>	<ul style="list-style-type: none"> <li>o Diagrams are unclear</li> </ul>	<ul style="list-style-type: none"> <li>o Diagrams clear</li> </ul>	<ul style="list-style-type: none"> <li>o Diagrams clear and catch the eye</li> </ul>
Data	<ul style="list-style-type: none"> <li>o Illegible or missing</li> </ul>	<ul style="list-style-type: none"> <li>o Complete but messy</li> </ul>	<ul style="list-style-type: none"> <li>o Minor omissions</li> </ul>	<ul style="list-style-type: none"> <li>o Neat and easy to read</li> </ul>
Graph	<ul style="list-style-type: none"> <li>o No Title</li> <li>o Axis not labelled</li> <li>o No line of best fit/connect the dots</li> </ul>	<ul style="list-style-type: none"> <li>o Title is not descriptive</li> <li>o Axis labelled but no units</li> <li>o Line of best fit not drawn with ruler</li> </ul>	<ul style="list-style-type: none"> <li>o Title is descriptive but not of form "F vs. a..."</li> <li>o Axis labelled with units but improper scale</li> <li>o Line of best fit drawn with ruler but goes through 0,0</li> </ul>	<ul style="list-style-type: none"> <li>o Title with the form "F vs. a..."</li> <li>o Axis labelled, with units and proper scale</li> <li>o Line of best fit drawn with ruler and <b>does not</b> go through 0,0</li> </ul>
Calculations	<ul style="list-style-type: none"> <li>o Major calculation work is missing</li> </ul>	<ul style="list-style-type: none"> <li>o Some minor calculation errors</li> </ul>	<ul style="list-style-type: none"> <li>o Slopes and y-intercepts calculated properly, but no units</li> </ul>	<ul style="list-style-type: none"> <li>o Slopes and y-intercepts calculated properly with appropriate units</li> </ul>
Discussion	<ul style="list-style-type: none"> <li>o Discussion missing</li> </ul>	<ul style="list-style-type: none"> <li>o Some discussion questions correctly and completely</li> </ul>	<ul style="list-style-type: none"> <li>o Most discussion questions correctly and completely</li> </ul>	<ul style="list-style-type: none"> <li>o All discussion questions answered correctly and completely</li> </ul>

Marked by: \_\_\_\_\_