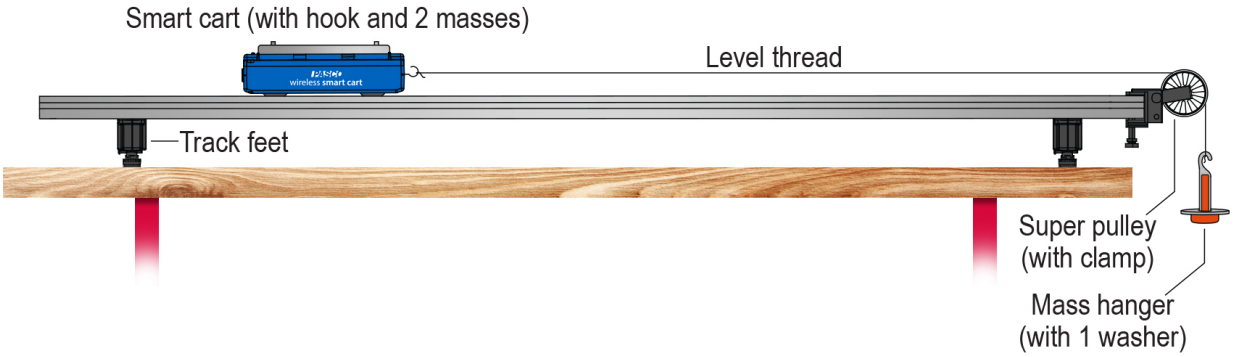
Investigation 5A: Newton's second law

Essential question: How is an object's acceleration related to the net force acting on the object?

When the forces acting on an object are unbalanced, the object accelerates. Newton's second law describes how an object's acceleration is related to the amount of net force acting on it. In this investigation you will explore this relationship.

Force and Acceleration

1. Open the **05A_NewtonsSecondLaw** experiment file in your software, and then connect your Smart Cart using Bluetooth.
2. Set up the equipment like the picture. Be sure the track is level.



3. In your software, zero the Smart Cart force sensor while nothing is touching the hook.
4. Pull the cart to the end of the track, or until the mass hanger hangs just below the pulley, and then record data as you release the cart to roll freely down the track. Catch the cart before it hits the pulley.
5. Record five trials of data using the same steps, adding one more washer to the mass hanger before each trial: Trial 1 = 1 washer, Trial 2 = 2 washers, Trial 3 = 3 washers, and so on.
6. For each trial, find the cart's acceleration (slope of velocity graph) and average net force on the cart (net force = force measured by the sensor) while it was rolling freely down the track (only while it was rolling freely). Record your values into Table 1.

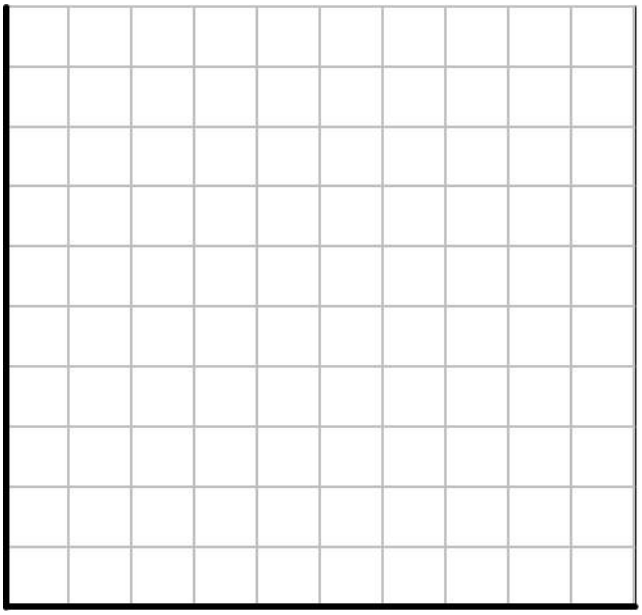
Table 1: Average net force and acceleration data of a cart

Trial	Net Force (N)	Acceleration (m/s^2)
1		
2		
3		
4		
5		

7. Go to the second page of the experiment file. Enter the data from Table 1 into the table in the experiment file. This data will appear in the graph on the same page.

Questions

a. Sketch a copy of your net force versus acceleration graph. Be sure to label the axes.



b. How was the cart's acceleration different when the applied net force was greater? Support your answer with data.

c. What is the shape of your net force versus acceleration graph?

d. What is the slope of your net force versus acceleration curve? How does the slope value compare to the total mass of the cart plus any mass on it?

e. There are two common mathematical expressions for Newton's Second Law. One of these expressions is $F = ma$. How does your data support this mathematical relationship?