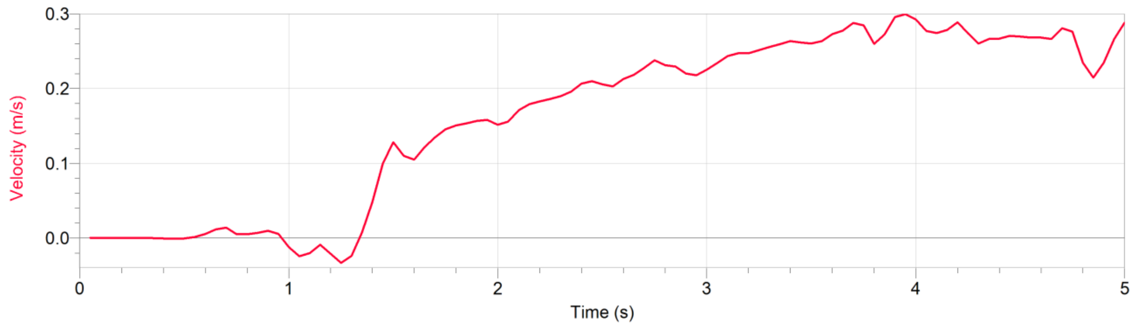
Newton's Second Law Lab

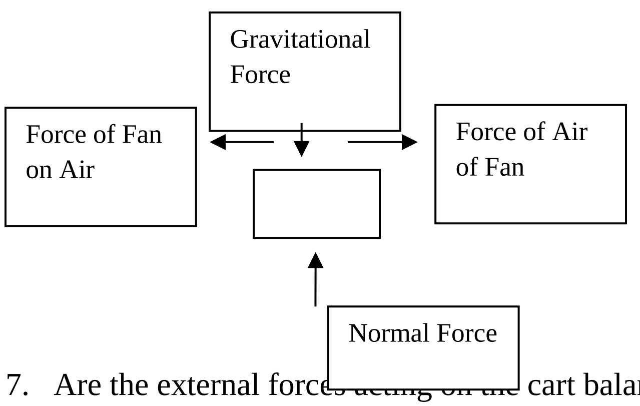
Station 1: Fan cart

1. Connect the motion sensor to one computer and open Logger Pro. You should see a position vs. time graph and a velocity vs. time graph on your screen.
2. Press the green "collect" button. After you hear the motion sensor clicking, turn the fan on and observe the motion of the cart.
3. Does it speed up, slow down, or move at a constant speed?

4. Right click on the velocity vs. time graph and auto scale it. Copy and paste the graph below. What can you say about the rate at which the velocity increases?
   The velocity increases at a constant rate.



5. List the forces that act on the cart: (Friction on the cart is small enough that it can be considered negligible.)
   Normal Force, Gravitational Force, Force of the air on the cart, and the force of the cart on the air
6. Draw a free body diagram for the cart. Use insert, shapes to insert a rectangle for the cart and arrows for the force vectors. Use text boxes to label the forces.



7. Are the external forces acting on the cart balanced or unbalanced?
   As the cart is increasing in velocity, the forces on the cart are unbalanced, but when it reaches a constant velocity, then the forces are balanced.

8. Conclusion: When the forces acting on the cart are (balanced/unbalanced), the cart (speeds up/slows down/moves at a constant speed).

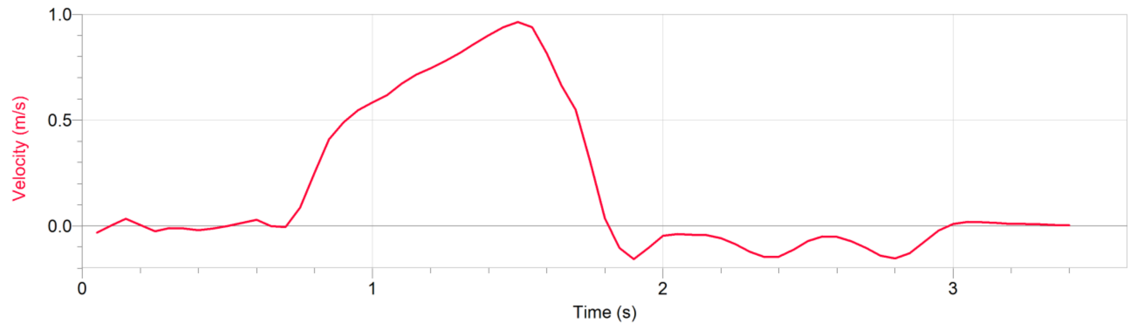
When the forces acting on the cart are balanced, the cart moves at a constant speed.

Station 2: Pasco cart with hanging mass

1. Use a pulley and a 50 g mass hanging off the end of the table to pull the cart with a constant force.
2. Place a motion sensor at the end of the track. Connect the motion sensor to one computer and open Logger Pro. Press the green "collect" button. After you hear the motion sensor clicking, let the hanging mass pull the string which in turn pulls the cart down the track.
3. Does the cart speed up, slow down, or move with a constant speed?

When the cart with the hanging mass is let go, the cart speeds up down the track.

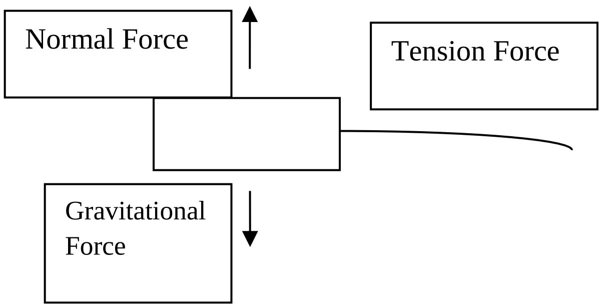
4. Copy and paste the velocity vs. time graph here.



5. List the forces that act on the cart: (Friction on the cart is small enough that it can be considered negligible.)

Gravitational force, normal force, applied force, and a tension force all act on the cart.

6. Draw a free body diagram for the cart. Are the external forces acting on the cart balanced or unbalanced?



7. Stack the small disk masses in the blue box on top of the cart. Move one at a time to the hanger. When you increase the amount of mass on the hanger, this increases the tension in the string. As the tension in the string increases, what happens to rate at which the velocity increases?

As the tension in the string increases, or the force of the cart increases, the acceleration of the cart increases substantially.

8. While keeping the amount of mass on the hanger constant, add mass to the cart. As you increase the mass on the cart, what happens to the rate at which the velocity increases?

When you add mass to the cart, the acceleration of the cart decreases substantially. This is because when you divide a smaller force by a larger mass the acceleration will be lower, compared if you divided a large force by a smaller mass.

Station 3: Bowling ball vs. basketball.

1. Hit suspended bowling ball with bat and then the basketball. Try to use same force.
2. Compare the motion of the balls.
   When the basketball and the bowling ball are hit with the a similar force, the basketball moves with much more motion than the bowling ball. This is because the basketball and bowling ball differ in mass substantially. The bowling ball has much more mass than the basketball, and therefore the basketball will have a larger acceleration than the bowling ball.

3. Why does one move more than the other even though the same force was applied?

As mentioned in the previous answer, the bowling ball has a much larger mass than the basketball. Because of the equation Acceleration= Force/ Mass, when the mass is larger there will be a smaller acceleration. That is why the basketball moves more than the bowling ball.

Conclusion:
How does the acceleration of an object depend on the net force acting on it and its mass?

It depends on it because of the equation acceleration=force/mass. When the mass of the object is larger there will be a smaller acceleration, when the force is kept the same. If the force is larger, and the mass is kept the same the acceleration will be larger, than if the force is smaller and the mass is larger.