Survey of Physics

Lab 6: Newton's Laws

Name:______________________

partner name(s):______________________

Theory:

Newton's Second Law states that the net force on an object equals its mass times its acceleration. When a fan accelerates a cart along a horizontal track, the downward gravity force is canceled by the upward force of the track. Then the fan provides the net force force on it, and we can find its force by $F_{\text{net}} = ma$.

When a person is on a weight scale and moving at a constant velocity (which includes being at rest), the scale reading equals the person's weight. This is usually how we use the scale, but the scale reading will not equal weight if the person is accelerating.

What the scale actually measures is the upward force applied to the person, called the normal force. When the elevator is accelerating (at the start or end of its travel) the normal force will not be the same as the weight. Then the ***net force*** will determine the person's acceleration. For a person standing on a scale, the net force is the sum of the positive normal force and the negative weight force.

Objectives:

- find a force by measurements of mass and acceleration.
- find the acceleration of the building elevators using Newton's 2^{nd} Law

Equipment: computer running Logger Pro, Vernier interface and motion detector, low friction cart with extra masses and electric fan, track, bathroom weight scale.

Part 1: *Cart with fan*

1. Connect the motion detector to the Vernier interface, and the interface to the computer. The motion detector should be positioned at the left, pointing toward the right.

2. Record the mass of the cart – this can be measured using the mass balances in the room, and can be changed by adding masses on top of it.

   $m_0 =$ ____________________ kg

3. Arrange the cart so the fan will slow it down and return it after you give it a push away from the detector. Measure the acceleration of the cart during this motion with the motion detector. You can measure acceleration by finding the slope of the velocity-time graph. Select the velocity graph, then click the “Linear Fit” button on the toolbar (see figure).

Make sure slope measurement only includes the "clean" data in the measurement (not the bumps that occur before and after the cart is moving freely) – you can do this by dragging the brackets on the velocity graph that define the domain for the linear fit.

$a_0 =$ ____________________ m/s²

4. Change the mass and repeat, getting accelerations for at least three different masses. Complete the table below, including the data above.

mass (kg)	acceleration (m/s^2)	force (N)
$m_0 =$	$a_0 =$	

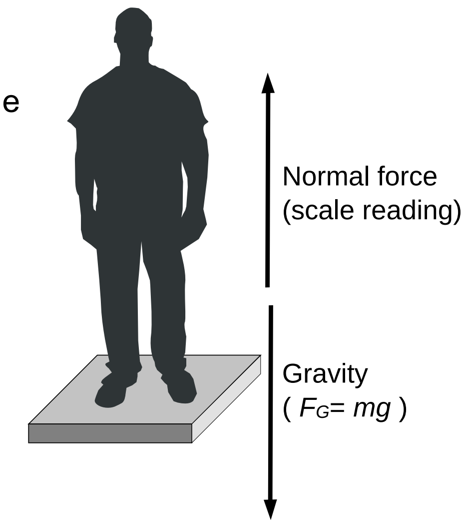
5. Use your measurements of mass and acceleration to compute the force provided by the fan, completing the table. You will need to use Newton's Second Law. Find the average force from your results.

$F_{ave} =$ _________________________ N

6. Does the force change substantially in each run? Do you expect it to?

Part 2: *Elevator acceleration*

In this part your object is to measure an elevator's acceleration. To do so you you will need to measure the weight of a person while not accelerating (their true weight $W = mg$), and the *apparent weight* of the person (what the scale reads) while the elevator is accelerating up and down.



Preliminary Questions:

A. Will the mass of the person change as the person accelerates?

B. Will the person's weight change as the person accelerates? (not the scale reading, the person's actual weight : mg)

Procedure:

1. Use the scale (while stationary) to measure the weight of the experimental subject in pounds (lbs). When not accelerating, the net force is zero, so the scale reading is equal to weight.

   W= ____________________ lb

   Find the weight in Newtons (1 lb = 4.45 N).

   W= ____________________ N

   Use the weight to find the subject's mass m in kg. ($W = mg$)

   $m =$____________________ kg

   With these numbers, complete the top row in the table on the next page.

2. Bring a scale to the elevator and measure the scale readings in pounds for the different types of motion shown. The normal force equals the scale reading, but should be given in Newtons. In the last column, find the ***net force*** on the person: the normal force upward minus gravity force ($W = mg$) downward. Use + for upward net force and – for downward net force.

Type of motion	**Scale reading (lbs)**	**Normal force (N)**	**Net Force (N)**
stationary			
Moving down, getting faster			
Moving down, slowing			
Moving up, getting faster			
Moving up, slowing			

3. Determine the elevator's acceleration in each case. Use + for upward acceleration and – for downward acceleration. ($F_{net} = ma$)

Type of motion	**Acceleration (m/s^2)**
stationary	
Moving down, getting faster	
Moving down, slowing	
Moving up, getting faster	
Moving up, slowing	