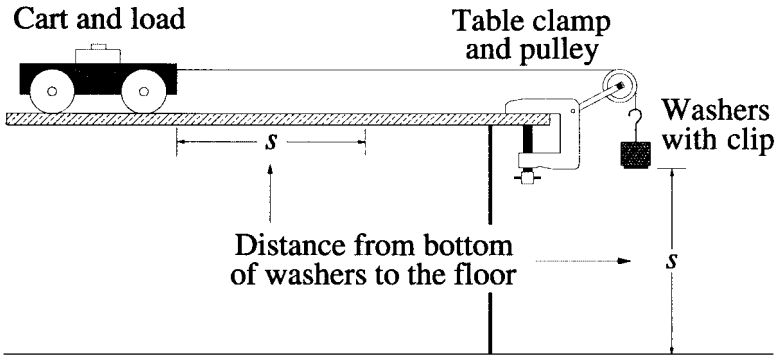
Name **Section #**

Newton's Second Law of Motion

Purpose

How is a body's acceleration affected by its mass and by the magnitude of the net force acting on it? Newton's Second Law states that $F = ma$ or, $a = F\frac{1}{m}$. We therefore expect the acceleration to be proportional to the net force F if the body's mass is kept constant and, if we keep the force constant, the acceleration should be proportional to $\frac{1}{m}$. In this experiment, m will consist of the cart with its load as shown in the figure below, while the number of hanging washers will represent the net force F.



Procedure

Part 1: a versus F *with mass kept constant.* Set up the apparatus as illustrated above and load the cart with 500 grams and 8 washers. To counteract the retarding effect of friction, hang an additional washer on the clip and give the cart a gentle push. If you observe that the cart accelerates, then one washer weight exceeds friction and you will have to weight the clip with other objects (e.g. paper clips) until a gentle push on the cart results in the cart moving with constant speed. After adjusting for friction, transfer one of the eight washers from the cart to the clip to act as the net force. Determine the cart's acceleration as follows: Measure the distance s between the hanging washers and the floor. Mark this distance on the table and carefully measure the time t it takes for the cart to accelerate over this distance s. The acceleration is given by the relationship $a = \frac{2s}{t^2}$. Enter your data on the first line of Table 1. For each successive line, transfer an additional washer from the cart to the clip and measure the new acceleration.

Part 2: a versus $\frac{1}{m}$ *with a constant net force of 1 washer.* Measure the masses of the cart and one washer using the triple beam balance. Load the cart with a 100 gram mass and adjust for friction as in part 1.

Add the washer to the clip and measure the cart's acceleration. Record your data on the first line of Table 2. The amount entered as m should be the combined mass of the cart + 1 washer + clips +100 grams. Fill in each successive line after adding an additional 100 grams to the cart, correcting for friction then loading the clip with the single washer, and taking new measurements.

Table 1: a vs. F (constant mass)

F (# of washers)	s (m)	t (s)	a (m/s^2)
1			
2			
3			
4			
5			
6			
7			
8			

Table 2: a vs. $1/m$ (constant force)

m (kg)	$\frac{1}{m}$ (kg^{-1})	s (m)	t (s)	a (m/s^2)

Analysis

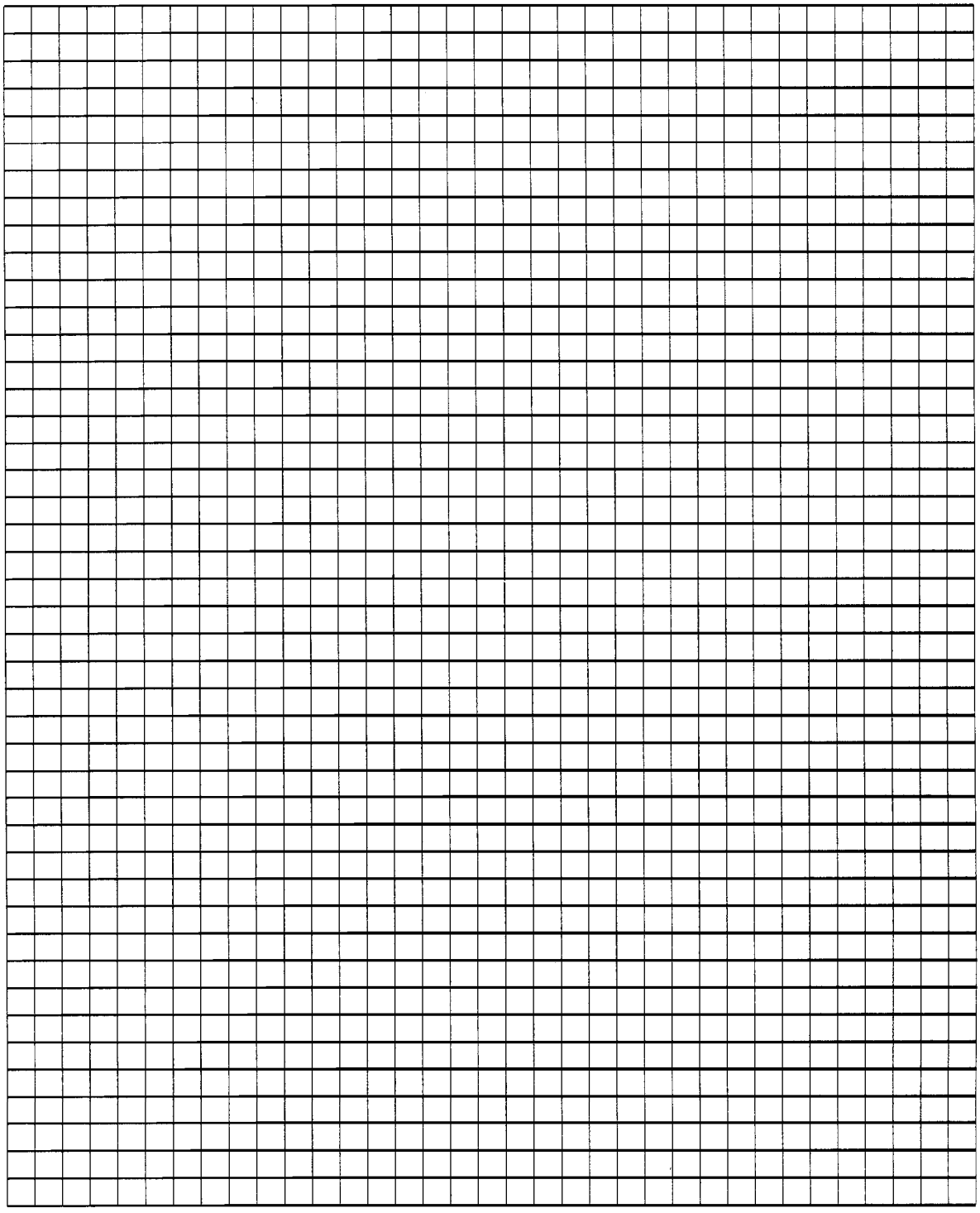
- Use your data from Table 1 to plot a best–fit line linking the acceleration a as the ordinate with the net force F as the abscissa. Measure the slope. State a conclusion based on your graph?

- Use your data from Table 2 to plot a best–fit line linking the acceleration a as the ordinate with $\frac{1}{m}$ as the abscissa. Measure the slope. State a conclusion based on your graph?

- What does the slope of each graph represent?

- Does your data and graphs agree with your expectations based on Newton's Second Law? If it does explain how, if not discuss possible causes of error.

Graph of *a* versus *F*



Graph of a versus $\frac{1}{m}$