Physics

name _____ period ____

Inv-6 Exploration - Loaded Carts

sheet #____

1.) Using masking tape, mark off a distance of **3.0 meters** on the floor of the lab.

2.) Use masking tape on your meter stick to mark the length to which you need to stretch your spring to achieve forces of **2.0 N, 4.0 N, 6.0 N, 8.0 N** and **10.0 N**.

3.) We have taped on enough masses to bring the total mass of each cart to 6.30 kg.

4.) Measure the time required for the cart to travel 3.0 meters under the influence of each of the forces listed above. Repeat the process and if you get a time that is within 5% of the first time, write it down and move on to the next force. If the two times aren't within 5%, repeat one more time. HELPFUL SUGGESTION: Start with a 4 Newton stretch so you can get your technique down.

DATA TABLE

Force (N)	Raw times (s)	Avg. Time (s)	Avg. vel (m/s	Final vel (m/s)	pf - pi Δp (kg·m/s)	Fill in after 5 % Error
Do this 4 one first	_____ _____ _____					
6	_____ _____ _____					
8	_____ _____ _____					
2	_____ _____ _____					
Do this 10 one last	_____ _____ _____					

** If you were the Duck Walker, give this to Askey and he will give you **Bonus:** + _____

5.) The most important word in Physics is "relationships". Newton understood momentum as moving inertia, but he wanted to know what caused momentum or caused the momentum of an object to change. He wanted to develop a mathematical relationship between the applied force and the resulting momentum change. Use the values you found in the table above to hopefully discover the same equation that Newton did that equates force (F) in column 1, time (t) in column 3 and change in momentum (Δp) in column 6. The three possibilities are given on the table to the right. Use the given formula for % Error to find the relationship with the least amount error for three of your trials.

Remember the formula for % error?

$$\frac{\text{your measured value} - \text{the true value}}{\text{the true value}} \times 100$$

Which of the three possible relationships has the lowest % error?

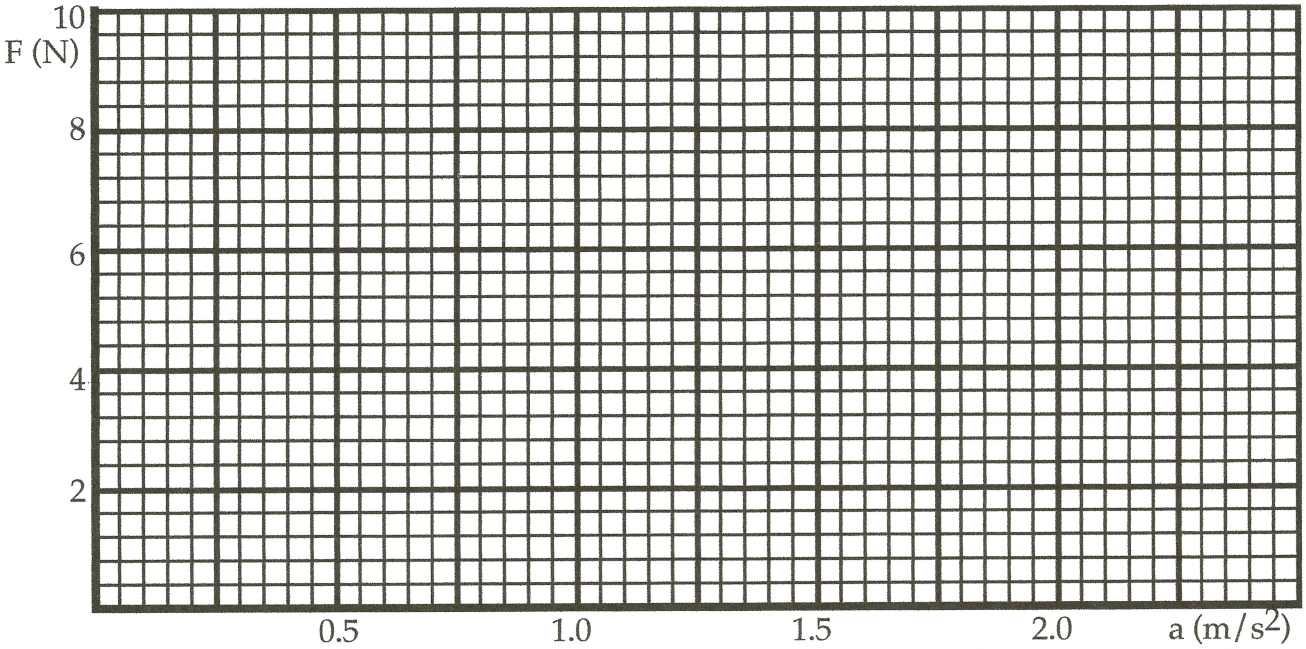
F	= t • Δp ?	= t / Δp ?	= Δp / t ?
4.0N			
6.0N			
8.0N			

6.) Now let's apply this new relationship between force and momentum. Assuming a standing start, how fast will a dynamic cart (**6.3 kg**) be moving after the duck walker put **10.0 N** of constant spring force on it for **3.15sec**?

7.) Now use one of your Orange kinematics equations to compute the acceleration of the cart for each force value.
Write the equation you used here ====>

Force (N)	2	4	6	8	10	
acceleration (m/s^2)						

8.) Make a graph of the force vs. acceleration with the force on the vertical coordinate and acceleration on the horizontal coordinate. (I realize independent and dependent are reversed.).



9a.) Askey will have your group plot your four best points on the class graph on the board . When all the groups have plotted their points, you can determine the class average function. Plot this class function on your graph above. Next, plot the theoretical relationship on the same graph after a class discussion,

9b.) What is the numerical value (withOUT units) of the slope on the class average graph? _____

9c.) What was your exact mass of your cart plus added weights? _____ So what is the equation of this class average line?

9d.) Now plot the best fit line using YOUR group points.

11.) Now that you know this form of Newton's 2nd Law, plot a 3rd line on the graph above that represents what the line SHOULD look like in theory.

12.)So this gives you a visual feel for how far off you were from the theoretical relationship. If your slope was within 10% of 6.3 kg, that is VERY good.my friend. Quantify your error by determining the percent error. Here is the formula:

$$\frac{\textit{Difference between the two slopes}}{\textit{correct slope} = 6.3kg} \times 100$$

10.) Let's use some simple derivative Calculus to show the steps needed to get from Newton's original 2nd Law to its more modern version.

13a.) What will be the acceleration of a **30 kg** object that is undergoing **12 N** of force?

13b.) By how many **m/s** will the velocity of a **50 kg** object change if **180 N** is applied for **one minute**?

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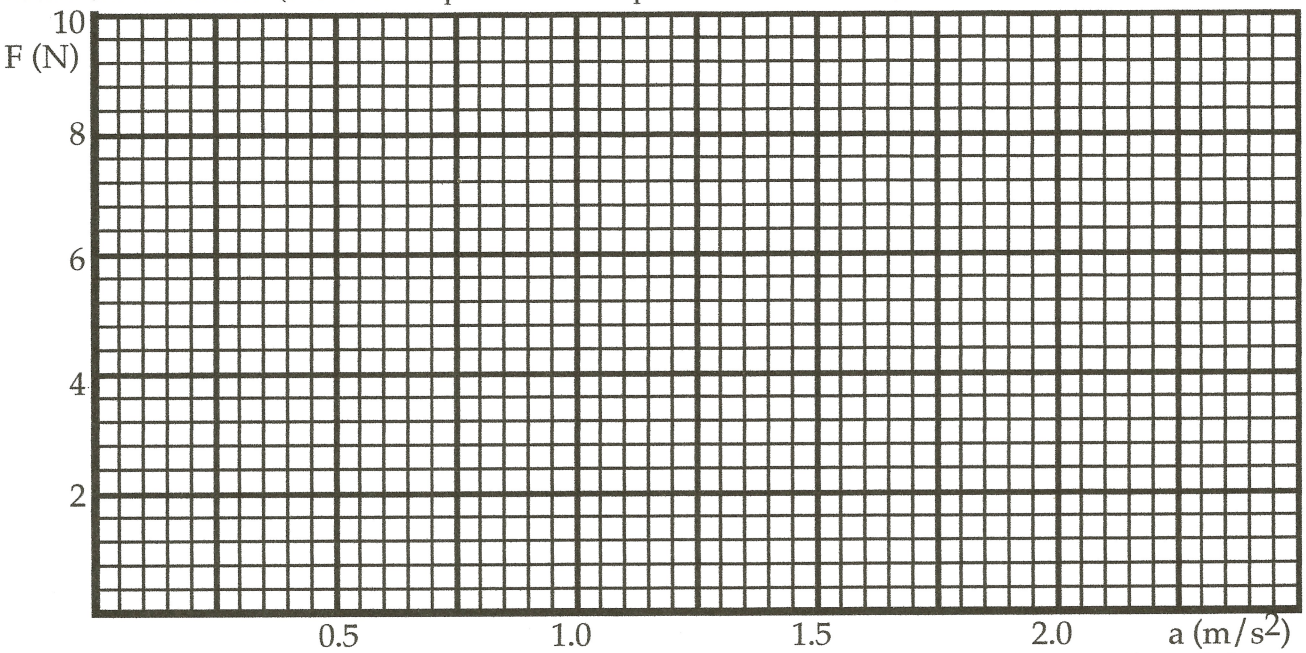

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