Physics Exploration Homework Supplement NS-001.pdf

Natural Sciences 1 - Fall 2004

HOMEWORK ASSIGNMENT #3 (Part 1)

(Due in recitation the week of September 20th)

Inclined Air Track Experiment

Objectives: First, to experimentally determine the changing velocity of a cart as it slides down an inclined air track and to use these data to find the average acceleration experienced by the cart. Second, to combine the result for the cart's acceleration with the known angle of incline of the track to calculate the value of the acceleration due to gravity.

Location: The apparatus (marked Natural Sciences 1) is set up in the Physics Exploration Center which you can access via the Physics Resource Room, 312 Thaw Hall. The lab is open during the hours from 9:00am through 4:00pm, Monday through Friday.

Summary of Procedure: When the blower is turned on, the airtrack provides a nearly frictionless surface for the cart to slide on. When the cart is released from rest at the fixed starting point, it speeds up as it slides down the track, which is inclined at a small angle. (See page 41 of your textbook for a description of a similar set-up.) Using a stopwatch, you will measure how long it takes the cart to slide through a series of marked, increasing distances down the track. Each time measurement is done three times, and you should use the average time value to calculate the average velocity of the cart as it traverses each of the successive distance increments. The resulting average velocity values are then to be used to determine the cart's acceleration a down the track. This acceleration a is related to the acceleration due to gravity g by a factor that takes into account the angle of incline of the track.

Equipment Provided:

1. Airtrack with cart, 2 cm thick metal spacer block
2. Stopwatch (Note: you have to push the stopwatch buttons quite hard.)

Step-by-Step Experimental Procedure:

1. Turn on the blower for the airtrack. The power supply is under the table.

2. Incline the airtrack by putting a 2 cm thick block under its right leg.

3. Measure the time it takes the sliding cart to move from the marked "start position" at the right of the inclined air track to the arrow that marks the 40 cm long distance. (There is a scale attached to the airtrack.) Line up the front of the cart with the starting line marker, then let the cart go from rest (be sure not to push it!) and concentrate on measuring the time it takes to go 40 cm. Make this measurement three times and record your time measurements in the appropriate boxes of the table on the following page.

4. Repeat Step 3 for the distances of 60 cm, 80 cm, and 100 cm. .

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Inclined Air Track Data and Calculations Sheet

(This sheet, along with your plot, will be collected in recitation.)

Your Name: ___________________________ Date_______________

Note: Each student must turn in an individual data sheet and plot.

Group Members' Names: ___________________________

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Data and Calculations:

Timings for the four distances on the air track:

distance (cm)	Trial #1: t (s)	Trial #2: t (s)	Trial #3: t (s)	Average time (s)
$d_0 = 0$	----------------------	---------------------	---------------------	$t_0 = 0$
$d_1 = 40$				$t_1 =$
$d_2 = 60$				$t_2 =$
$d_3 = 80$				$t_3 =$
$d_4 = 100$				$t_4 =$

Calculation of average velocities and midpoints of time intervals:

Average velocities (cm/s) = change in distance / time	Midpoints of Added Time Intervals (s)
$v_1 = (d_1)/(t_1) =$	$T_1 = (t_1)/2 =$
$v_2 = (d_2-d_1)/(t_2-t_1) =$	$T_2 = (t_1+t_2)/2 =$
$v_3 = (d_3-d_2)/(t_3-t_2) =$	$T_3 = (t_2+t_3)/2 =$
$v_4 = (d_4-d_3)/(t_4-t_3) =$	$T_4 = (t_3+t_4)/2 =$

1. On a separate page, make a careful plot of the four average velocities vs. the midpoints of the respective time intervals over which they were measured, using the values you calculated in the table just above. As a fifth data point you may use the knowledge that the cart's velocity was zero at time T=0. Plot the average velocities on the vertical axis and the midpoints of the time intervals on the horizontal axis. Make sure to label the scales on your axes. Use a ruler or graph paper to make an accurate plot. Draw a "best-fit" straight line through your data points. Note that your line may not pass through all (or any) of your measured data points because of measurement uncertainties.

2. Determine the slope of this line (slope = rise/run). The value of this slope represents the acceleration a experienced by the cart as it slid down the track.

3. Calculate the acceleration due to gravity, g, as follows: the acceleration a you determined in the preceding step is related to g by the equation $a = g \cdot \sin\theta$. Therefore $g = a/\sin\theta$. θ is the angle of incline of the track; the 2 cm thick block produces an incline of $\theta = 1.146$ degrees. How does your answer for g compare to the known value $g = 980\ cm/s^2$?

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HOMEWORK ASSIGNMENT #3 (Part 2)

(For discussion in recitation the week of September 20th)

Recitation Discussion Questions

(Please be prepared to discuss these, but your answers need not be turned in)

1) Which of the following objects are in uniform motion? Which are in accelerated motion?

    a) A car driving North at 35 mph along a straight and level road.
    b) A car going around a curve at a constant speed of 50 mph.
    c) A dolphin leaping out of the water.
    d) A person going up in an elevator at constant speed.
    e) A flower pot falling out of a third floor window.

2) From your everyday experience, give three examples of objects at rest. For each of your examples, identify all of the forces that act on the object. What does Newton's First Law tell you about the relationship between these forces?

3) From your everyday experience, give three examples of objects that are undergoing constant acceleration. For each of your examples, identify all of the forces that act on the object. What does Newton's Second Law tell you about these forces?

4) Describe the action-reaction pair of forces that acts in each of the following situations:

    a) A pitcher as he throws a fastball.
    b) An apple as it falls to the ground.
    c) A pencil resting on your desk.

5) A mule hitched to the front of a cart refuses to try to pull the cart, citing Newton's Third Law as evidence of the futility of such an effort: "When I pull on the cart, there is always an equal and opposite force, so no matter how hard I try to pull, these forces will always cancel." Is the mule right?