CLASS COPY – *For your own copy, find this document under* **"Physics - Labs."**

UNIFORM ACCELERATED MOTION WITH THE CAR AND RAMP

Purpose: *To determine the acceleration of a car as it rolls down a ramp inclined at a constant angle and to obtain a result that is within 3% of the accepted value.*

Materials:

- CPO timer and photogates
- Ramp
- Car
- 1 square weight
- Physics stand
- Meter Stick
- Vernier Caliper (optional)

Procedure:

1. Set up the Car and Ramp equipment as shown in class:
   a. If it is not already attached, insert the foot into the base of the ramp so that the track for the car's wheels is on the top.
   b. Insert the ramp into the 6th hole from the bottom of the physics stand and secure with the knob.
   c. Attach the square weight on the car and secure it with the wing nut.
2. Set up the CPO Timer and Photogates as shown in class:
   a. Attach one gate (Gate A) near the top of the ramp—approximately 1 cm in front of the wing of the car when the car is all the way at the top of the ramp. Connect this photogate to jack "A" on the timer box.
   b. Attach the second gate (Gate B) approximately 5-8 cm down from gate A. Connect this gate to jack "B" on the timer box.
3. Measure the length of the "wing" on the car
4. Measure the position of gate A, using the top end of the ramp as the reference point. Make sure to measure to the center of the hole on the top of the gate, where the light beam is located.
5. Measure the position of gate B.
6. Release the car from the very top of the ramp, making sure the wing of the car is passing through the photogates.
   a. Record the following pieces of data from the timer box (1 trial gives you 3 measurements!):
   b. The time it took the car to travel through gate A
   c. The time it took the car to travel through gate B
   d. The total time it took the car to pass from gate A to gate B
7. Repeat step 6 for a minimum of 3 trials.
8. Move Gate B approximately 5 cm further down the track and repeat steps 5-7.
9. Repeat step 8 as many times as you can throughout the length of the track (min. 8)

Data Collection:

1. Create a table in which to report all raw data collected during this lab.

Data Analysis - Calculations:

1. Create a second table in which to report the calculations listed below. Directly following the table, be sure to include one worked-out example for each type of calculation completed (equation, plug in values, circle final answer with units).
    a. **Average**s for the following:
        i. Time through gate A
        ii. Time through gate B at *each separate* position
        iii. Total time from gate A to gate B for each position of gate B
    b. **Initial velocity** (the velocity through gate A)—use average time through gate A
    c. Velocity at each position of gate B (use average time through gate B for each position)—this is the **final velocity** of the car

Data Analysis – Graphs: *(4 graphs)*

1. Create the following graphs—remember, you and your partner(s) are each expected to create your own graphs!!! (and they aren't necessarily both linear)
    a. Graph 1: Position vs. total time
    b. Graph 2: Velocity vs. total time (note: the velocity at t = 0.0 sec is equal to the velocity at gate A)

2. What are the equations for each of your lines? When you write them out, substitute the appropriate variable letter (v for velocity, d for distance (*position)* and t for time) for the "y" and the "x" in the computer-generated equation
    a. Position vs. time:
    b. Velocity vs. time:

3. Is it possible to easily determine the acceleration from both of these graphs? If so, how? If not, why not?

4. Create 2 more **linear** graphs, this time of the following information:
    a. Graph 3: position (y-axis) vs. total time squared (x-axis) [d vs. t^2]
    b. Graph 4: (velocity at gate B) squared (y-axis) vs. position (x-axis)

5. List the slopes for graphs 2, 3, and 4:
    - Graph 2:_____
    - Graph 3:_____
    - Graph 4:_____

6. Compare the slopes for each of these graphs—are there any mathematical patterns that you can see with these values? (For example, is one double another?)

7. What is the acceleration of the car down the ramp, according to your data and calculations (use graph 2)? Compare your value to the accepted value (given in class) by completing a percent error calculation.

Conclusion:

1. Write a conclusion according to the guidelines in your lab grading sheet.