Motion on an Inclined Plane
Sample lab report

Purpose: To find the mathematical model for displacement (Δx), velocity (v) and acceleration (a) vs. time for an object starting form rest and rolling down a (fairly) frictionless inclined plane or ramp.

Hypothesis: Displacement will be directly proportional to time squared, velocity will be directly proportional to time, and acceleration will be constant. Since the object is moving down an incline with a constant slope, the object's velocity will increase at a constant rate (this rate is known as acceleration). It will cover more and more distance in each successive second as the velocity increases.
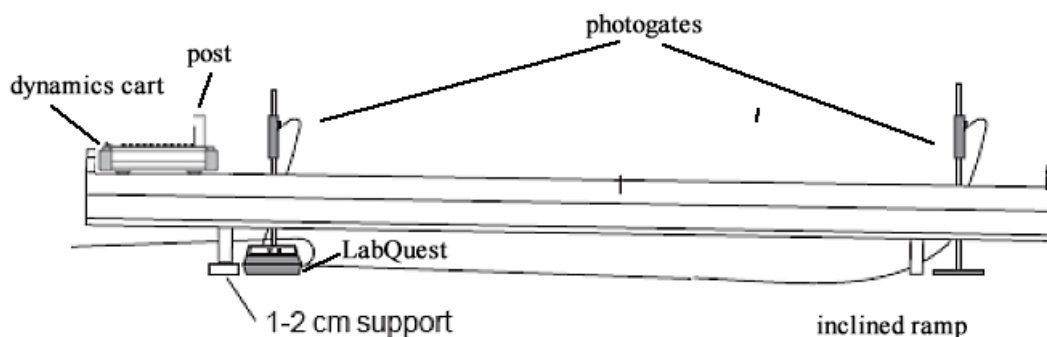
Apparatus:

dynamics cart	post to screw to cart
inclined ramp	1-2cm support
meter stick or ruler on dynamics system (ramp)	2 photogates

Procedure:
1. Set up the apparatus as shown in the figure above. Daisy chain photogate 2 to photogate 1 as shown at the right. Plug photogate 1 into DIG1 on the Labquest.
2. Tap "Mode" on the LabQuest screen and change "Photogate Mode" to "Pulse."
3. Measure the displacement between the photogates using the ruler on the inclined plane.
4. Align the dynamics cart so that the post is just before the first photogate (this makes the initial velocity of the cart zero).
5. Hit "collect" on the LabQuest and release the cart. Record the "pusle time" or the time to get from gate 1 to gate 2.
6. Repeat steps 4 and 5 twice more.
7. Repeat steps 3-6 five more times changing the distance between the photogates each time by moving the second gate.

Data:
Angle of incline is kept at a constant

Δx (cm)	Time (s)			
	Trial 1	Trial 2	Trial 3	average
180.0	2.0453	2.1010	1.9897	2.0
150.0	1.8787	1.9000	1.8421	1.9
120.0	1.6803	1.7201	1.5999	1.7
90.0	1.3999	1.4552	1.4989	1.5
60.0	1.1882	1.2000	1.1223	1.2
30.0	0.9021	0.8402	0.8000	0.8

Data Analysis:
Displacement is graphed on the y-axis even though it is the independent variable so the slope of the tangents to the curves will equal instantaneous velocity.

$$\Delta x = (43.41 \text{ cm/s}^2) \, t^2$$

Instantaneous velocity is found by finding the slope of a tangent line to the Δx vs t curve at various times using a TI-83 calculator.

Time (s)	Velocity (cm/s)
2.0	173.6
1.9	165.0
1.7	147.6
1.5	130.2
1.2	104.2
0.8	69.5

$$V = (86.80 \text{cm/s}^2) \, t$$

Acceleration is found by finding the slope of the velocity vs time graph which is constant.

$$a = 86.80 \text{cm/s}^2$$

Conclusion:
Displacement is directly proportional to time squared as shown by the equation $\Delta x = (43.41 \text{ cm/s}^2) \, t^2$. Slopes of tangents to this curve gave the instantaneous velocity. Velocity is directly proportional to time as shown by the equation $V = (86.80 \text{cm/s}^2) \, t$. Acceleration is constant, a = 86.80cm/s^2 and is given by the slope of the velocity graph. The y-intercepts of both the displacement and velocity graphs are zero because at time = 0 s, the object started at zero position with zero velocity. These results agree with my hypothesis. In the equation for displacement vs time, 43.41 cm/s^2 is ½ of the acceleration so the general equation relating displacement, acceleration and time is $\Delta x = ½ \, a \, t^2$. Experimental error could have occurred if the cart did not start with a zero velocity. It was hard to place it exactly before the photogate without starting the timing. An initial velocity would make the time between photogates too short. Also, the distance between the photogates could have been off by ±0.5cm. I was trying to measured from the middle of one photogate to the next using the ruler on the inclined plane which was a little distance away from the photogate. To improve the experiment next time, I would put a release gate at the first photogate to make sure the cart always started from the same point and use a meter stick to measure from one gate to the next since I could move this closer to the gates making it easier to read.