Date of Lab 9/27 Date of Submission 10/6

# Laboratory Report

Title: Analyzing the motion of Dynamics Cart with a Spark Timer.

| Homeroom | Section | Name | |
|---|---|---|---|
| 11-E | | | Kakeru Ito |

Lab Partners: Yuichi Watanabe


## Summary

We recorded and analyzed the acceleration rate of a dynamics cart that runs down ~~the~~ a slope by using a spark timer. We also changed the slope angle and the weight of the cart, and recorded & analyzed the data. In this experiment we saw that the angle of the slope was directly proportional to the acceleration rate but the weight affected accel. rate only a little. In addition, because the shape of v-t graph was a straight line, it is constant accelerated motion.


・Meet a deadline ・Write logically ・Write clearly ・Write with your own words

Teacher's Comments

A good summary. Beautiful and clear English.

The table summingup data is very good

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Due | Summary | Intro. | Method. | Results | Table/Fig. | Discussion | Clearness | General |
| + | ++ | | | | ++ | + | + | ++ |

* Use this form as a cover sheet.

* Submit your reports by the seventh day after your lab.

Physics Lab-001 11-E Kakeru Ito

# Analysis of Accelerated Motion Using a Spark Timer

## Introduction

Purpose:

This experiment was held in order to analyze how the angles of slope and the weight affect the acceleration rate of the motion of a cart by using a spark timer and dynamics cart.

Theory:

The cart runs on the straight line with constant acceleration. So it is a constant accelerated motion.

In this experiment, I use the following equations to find average acceleration rate;

1) $a=\Delta v/\Delta t$

2) $V=V_0+at$

3) $x=1/2at^2+V_0t$

4) $V^2-V_0^2=2ax$

Hypothesis:

The weight of the cart and the angle of the slope are both directly proportional to its acceleration rate.

Experimental Design:

In this experiment, I provide two different weights of dynamics cart and two different angles of the slope, which means I would have four different situations;

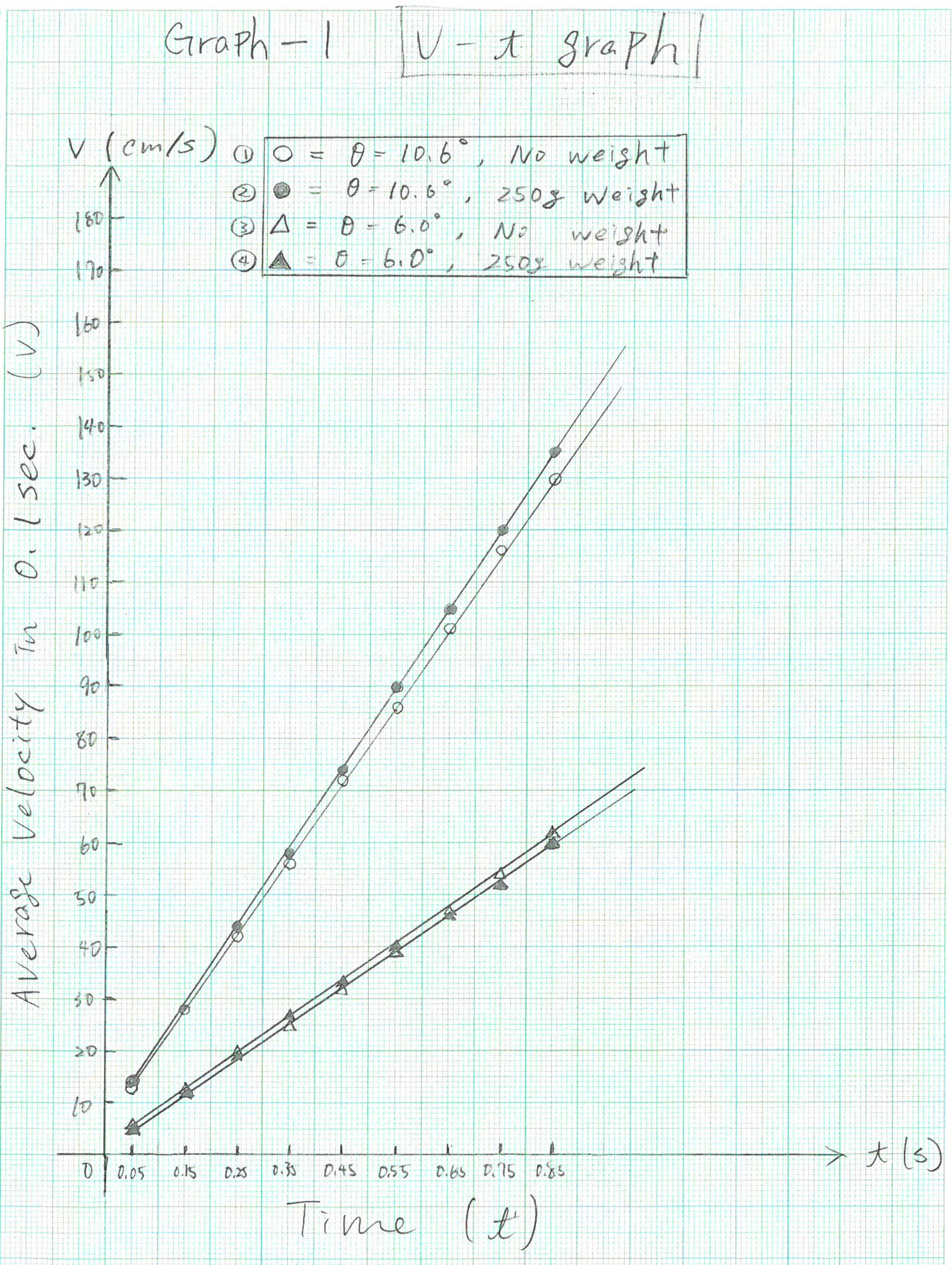
1) Less weight; Less slope
2) Less weight; More slope
3) More weight; Less slope
4) More weight; More slope

## Experiment;

Preparation;
Dynamics cart (500g), Weights (250g), Track, Ruler, Thermal Recording Tape, Extension cord, scissors, glue, graph paper, spark timer.

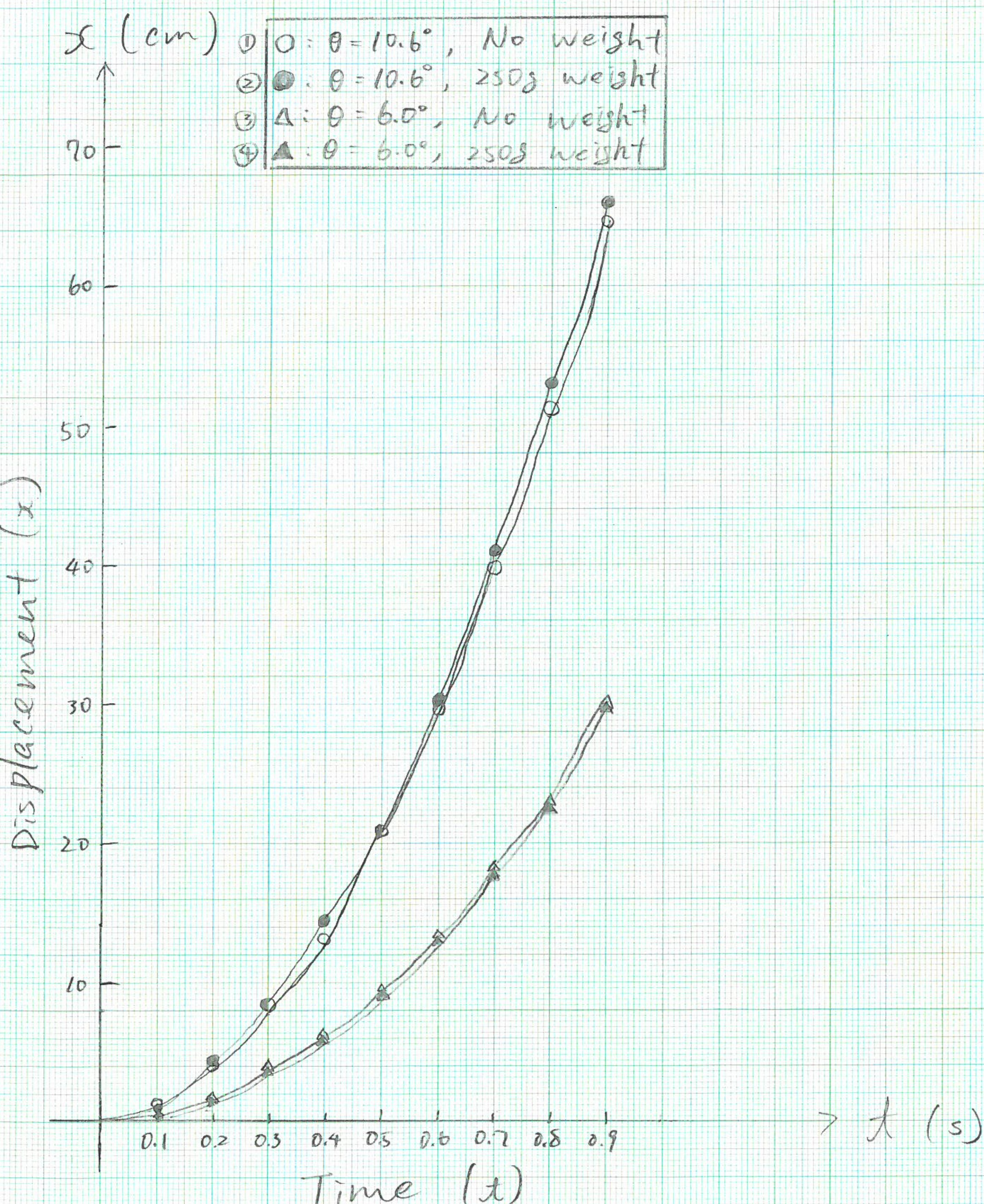
### Procedure;

1) Set up a track with a certain angles.
2) Measure the height and length of the track, and calculate the angle by using tangent.
3) Put the thermal recording tape, about the length of a yard, on the dynamics cart and the spark timer.
4) Turn on the power of the spark timer and make the cart run down the slope. Be sure to make it run down naturally. The initial velocity has to be 0.
5) Turn off the power and look at the recording tape.
6) Divide it into some pieces so that each of them have 6 dots, and analyze it.
7) Take the same procedure for the other three situations; the same slope and more weight, more slope and no weight, more slope and more weight.



Graph - 1
V - t graph
V (cm/s)
① ○ = θ = 10.6°, No weight
② ● = θ = 10.6°, 250g weight
③ △ = θ = 6.0°, No weight
④ ▲ = θ = 6.0°, 250g weight
Average Velocity in 0.1 sec. (V)
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
0.05
0.15
0.25
0.35
0.45
0.55
0.65
0.75
0.85
t (s)
Time (t)

# Graph-2 | x - t graph



Result

| PhysicsLab-001 | Analyzing the Motion of Dynamics Cart with a Spark Timer |
|---|---|

Example

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time $t$ [s] | 0 | 0.100 | 0.200 | 0.300 | 0.400 | 0.500 | 0.600 | 0.700 | 0.800 | 0.900 |
| Displacement $x$ [x $10^{-2}$ m] | 0 | 2.35 | 6.25 | 11.65 | 18.60 | 27.15 | 37.24 | 48.85 | 61.95 | 76.65 |
| Displacement per 0.100 s $\Delta x$ [x $10^{-2}$ m] | 2.35 | 3.90 | 5.40 | 6.95 | 8.55 | 10.09 | 11.61 | 13.10 | 14.70 | |
| Average velocity $v$ [x $10^{-2}$ m/s] | 23.5 | 39.0 | 54.0 | 69.5 | 85.5 | 100.9 | 116.1 | 131.0 | 147.0 | |
| Time at central point $t$ [s] | 0.05 | 0.15 | 0.25 | 0.35 | 0.45 | 0.55 | 0.65 | 0.75 | 0.85 | |

① Condition: $\theta = 10.6°$, No weight  $a = \frac{130 - 13}{0.85 - 0.05} = \frac{1.17 m/s}{0.80 s} =$ 1.46 m/s²

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time $t$ [s] | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| Displacement $x$ [x $10^{-2}$ m] | 0 | 1.3 | 4.1 | 8.3 | 13.9 | 21.1 | 29.7 | 39.8 | 51.4 | 64.4 |
| Displacement per 0.100 s $\Delta x$ [x $10^{-2}$ m] | 1.3 | 2.8 | 4.2 | 5.6 | 7.2 | 8.6 | 10.1 | 11.6 | 13.0 | |
| Average velocity $v$ [x $10^{-2}$ m/s] | 13 | 28 | 42 | 56 | 72 | 86 | 101 | 116 | 130 | |
| Time at central point $t$ [s] | 0.05 | 0.15 | 0.25 | 0.35 | 0.45 | 0.55 | 0.65 | 0.75 | 0.85 | |

② Condition: $\theta = 10.6°$, 250g weight  $a = \frac{135 - 14}{0.85 - 0.05} = \frac{1.21 m/s}{0.80 s} =$ 1.51 m/s²

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time $t$ [s] | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| Displacement $x$ [x $10^{-2}$ m] | 0 | 1.4 | 4.2 | 8.6 | 14.4 | 21.8 | 30.8 | 41.3 | 53.3 | 66.8 |
| Displacement per 0.100 s $\Delta x$ [x $10^{-2}$ m] | 1.4 | 2.8 | 4.4 | 5.8 | 7.4 | 9.0 | 10.5 | 12.0 | 13.5 | |
| Average velocity $v$ [x $10^{-2}$ m/s] | 14 | 28 | 44 | 58 | 74 | 90 | 105 | 120 | 135 | |
| Time at central point $t$ [s] | 0.05 | 0.15 | 0.25 | 0.35 | 0.45 | 0.55 | 0.65 | 0.75 | 0.85 | |

③ Condition: $\theta = 6.0°$, No weight  $a = \frac{62 - 6}{0.85 - 0.05} = \frac{0.56 m/s}{0.80 s} =$ 0.70 m/s²

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time $t$ [s] | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| Displacement $x$ [x $10^{-2}$ m] | 0 | 0.6 | 1.9 | 3.9 | 6.4 | 9.6 | 13.5 | 18.2 | 23.6 | 29.8 |
| Displacement per 0.100 s $\Delta x$ [x $10^{-2}$ m] | 0.6 | 1.3 | 2.0 | 2.5 | 3.2 | 3.9 | 4.7 | 5.4 | 6.2 | |
| Average velocity $v$ [x $10^{-2}$ m/s] | 6 | 13 | 20 | 25 | 32 | 39 | 47 | 54 | 62 | |
| Time at central point $t$ [s] | 0.05 | 0.15 | 0.25 | 0.35 | 0.45 | 0.55 | 0.65 | 0.75 | 0.85 | |

④ Condition: $\theta = 6.0°$, 250g weight  $a = \frac{60 - 5}{0.85 - 0.05} = \frac{0.55 m/s}{0.80 s} =$ 0.69 m/s²

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time $t$ [s] | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| Displacement $x$ [x $10^{-2}$ m] | 0 | 0.5 | 1.7 | 3.6 | 6.3 | 9.6 | 13.6 | 18.2 | 23.5 | 29.5 |
| Displacement per 0.100 s $\Delta x$ [x $10^{-2}$ m] | 0.5 | 1.2 | 1.9 | 2.7 | 3.3 | 4.0 | 4.6 | 5.3 | 6.0 | |
| Average velocity $v$ [x $10^{-2}$ m/s] | 5 | 12 | 19 | 27 | 33 | 40 | 46 | 53 | 60 | |
| Time at central point $t$ [s] | 0.05 | 0.15 | 0.25 | 0.35 | 0.45 | 0.55 | 0.65 | 0.75 | 0.85 | |

Condition:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time $t$ [s] | | | | | | | | | | |
| Displacement $x$ [x $10^{-2}$ m] | | | | | | | | | | |
| Displacement per 0.100 s $\Delta x$ [x $10^{-2}$ m] | | | | | | | | | | |
| Average velocity $v$ [x $10^{-2}$ m/s] | | | | | | | | | | |
| Time at central point $t$ [s] | | | | | | | | | | |

## Result;

| Experiment | Angle (° ) | Weight (g) | Acceleration Rate (m/s²) |
|---|---|---|---|
| ① | 10.6 | 0 | 1.46m/s² |
| ② | 10.6 | 250 | 1.51m/s² |
| ③ | 6.0 | 0 | 0.70m/s² |
| ④ | 6.0 | 250 | 0.69m/s² |

## Discussion;

As you can see from the graph and the data table, the acceleration rates of Experiment① and Experiment② are almost identical to each other, even though the cart's weight is different. Additionally, the acceleration rates of Experiment① and Experiment② are also almost the same, regardless of their carts' weight. This proves that the weight of the cart doesn't affect its acceleration rate significantly.

On the other hand, when I changed the slope of the track on which the cart runs, the acceleration rate of the cart was also changed. Steeper the slope is, the greater the acceleration rate is. For example, Experiment 1 and 3 have different slope, the same weight, and different acceleration rate.

In addition, it can be said that the all motions of the dynamics cart observed in Experiment 1, 2, 3, and 4, are constant accelerated motion because the v-t graph shows four straight lines.

Although the weight of the object affects its acceleration rate insignificantly, I could see slight difference between the results. I think this is because of the effect of the air resistance and the friction between the tire of the cart and the track.

## Conclusion;

The weight of the object does not affect its acceleration rate, and the angle of slope is directly proportional to its acceleration rate. Therefore, my hypothesis was rejected. Because of the air resistance and friction I technically couldn't obtain the accurate results, but I could figure out how the weight of the object and the angle of the slope affect its acceleration rate.

Opinion;

I learned how to utilize the knowledge that I obtained in class in the real situation through this experiment. And I was also surprised that my hypothesis wasn't right. I thought that the weight has something to do with its acceleration rate.