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PHYS 211X
Lab 2: Acceleration and Force, 2/7/2023, Partners: Maite Valentin-Lugo, Seth Waln

Part 1: Speeding Up

1.

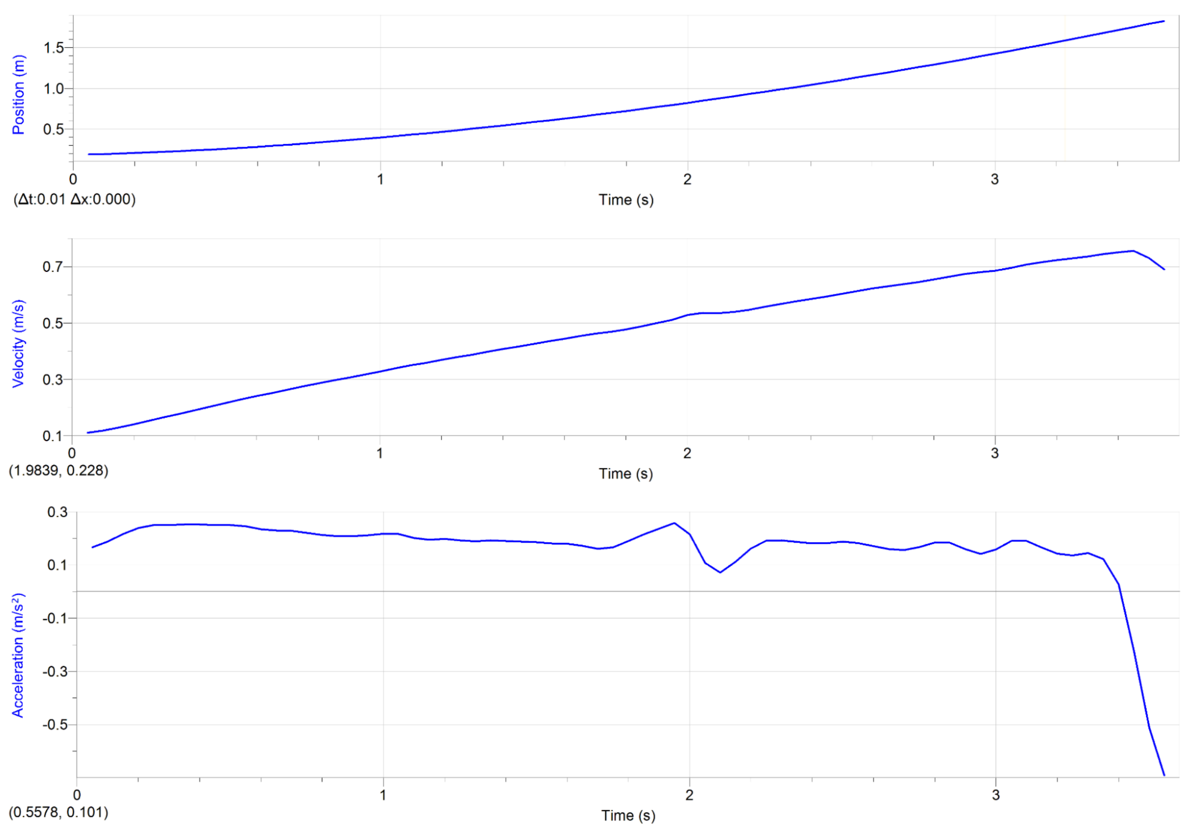
$$\vec{a} = \frac{\mathrm{d}\vec{v}}{\mathrm{d}t} \tag{1}$$

Acceleration is the derivative of velocity; it describes the rate of change of the velocity.

$$\sum \vec{F} = m\vec{a} \tag{2}$$

Forces are a sum or integral of the mass and acceleration applied to something.

2.



3.

Statistics for: Latest | Acceleration

min: 0.07098 at 2.100 max: 0.2578 at 1.950

mean: 0.1908 median: 0.1899

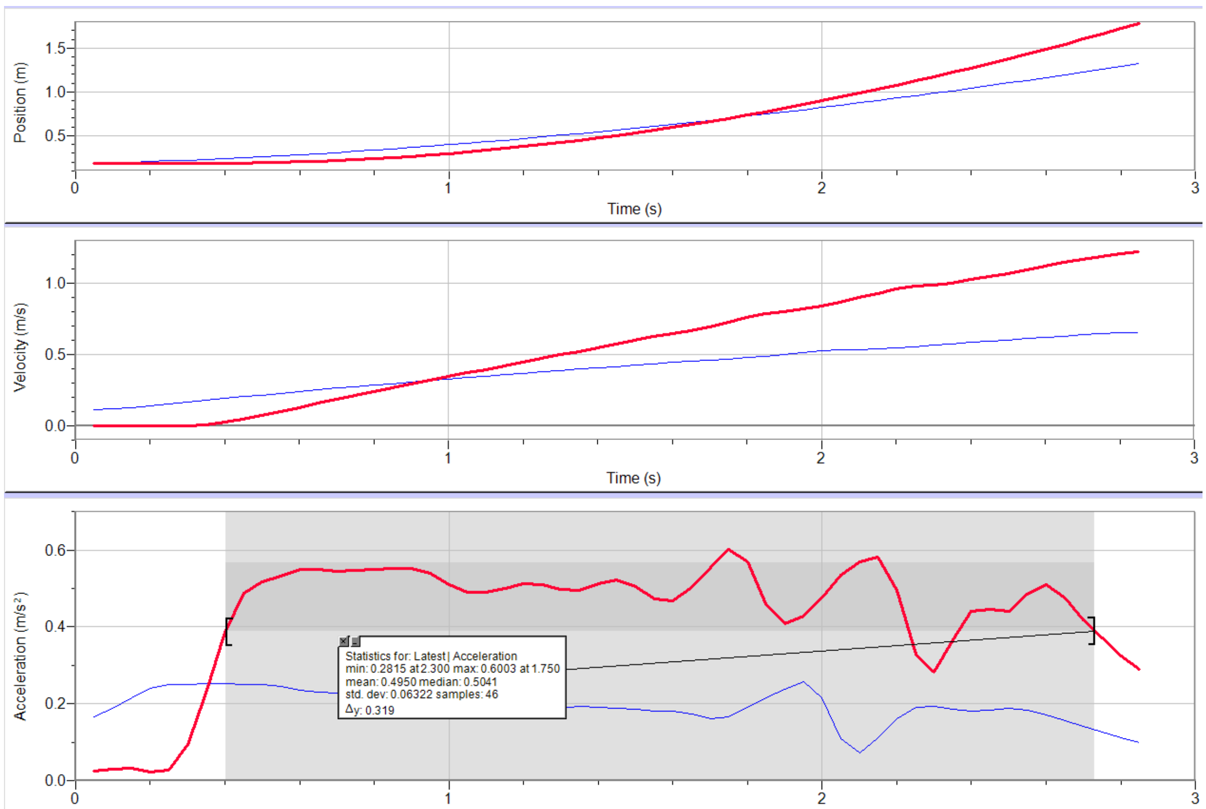
std. dev: 0.03808 samples: 67

Δy: 0.187

4.

If the initial mass is doubled, the acceleration will be doubled, making the velocity increase at twice the rate and resulting in the cart traveling the same distance in $\sim {}^1\!/_4$ the time.

5.

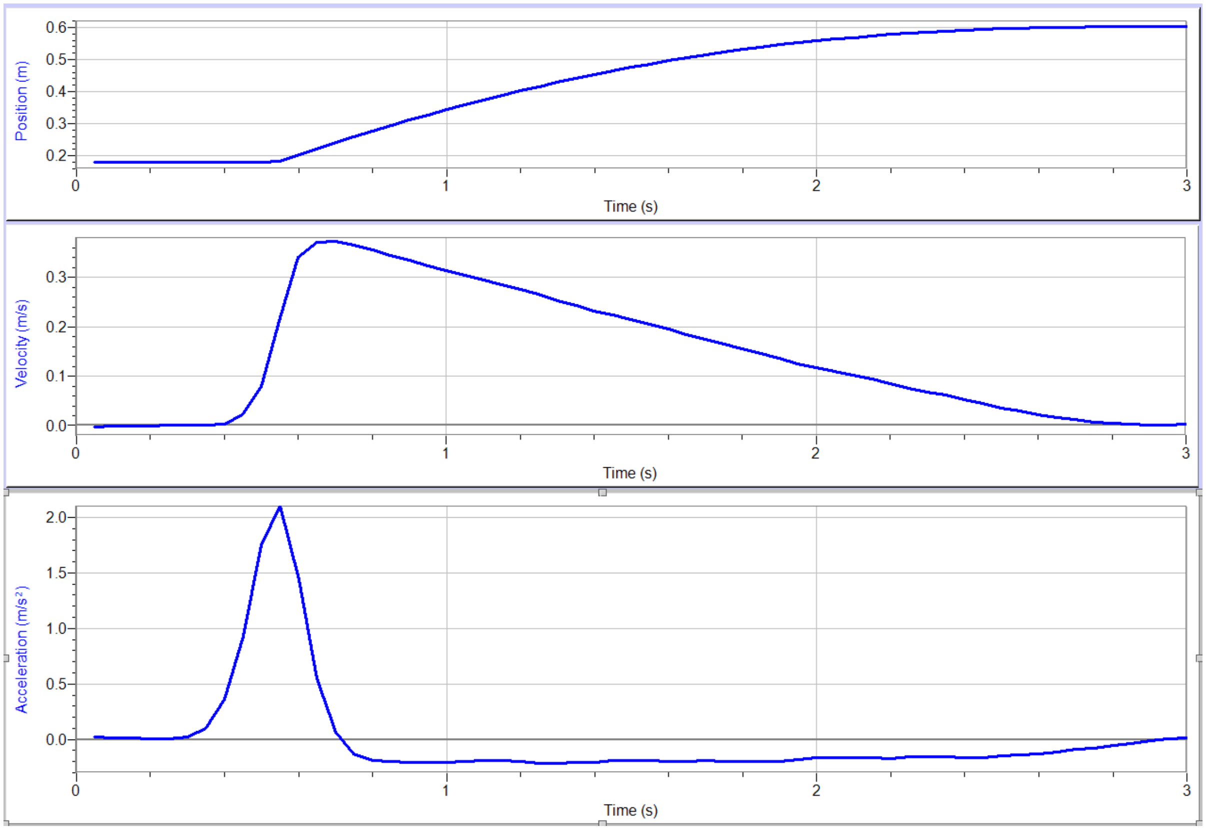


Part 2: Slowing Down

6.

The acceleration would be negative because the cart will decelerate to a stop, with the vector of the deceleration being pointed toward the sensor.

7.



Statistics for: Latest | Acceleration

min: -0.2118 at 1.250 max: 0.01807 at 3.000

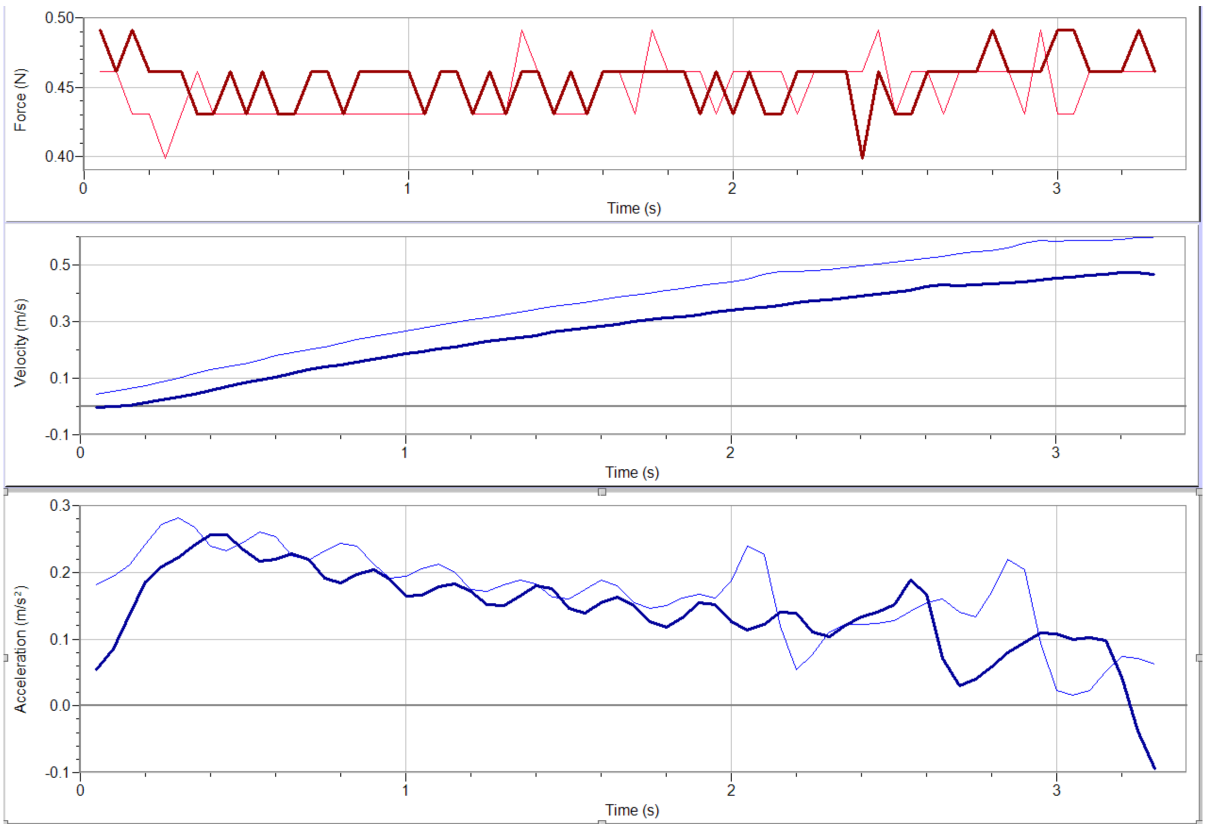
mean: -0.1586 median: -0.1858

std. dev: 0.06011 samples: 45

Δy: 0.230

Part 3: Force

8.,9.,10.



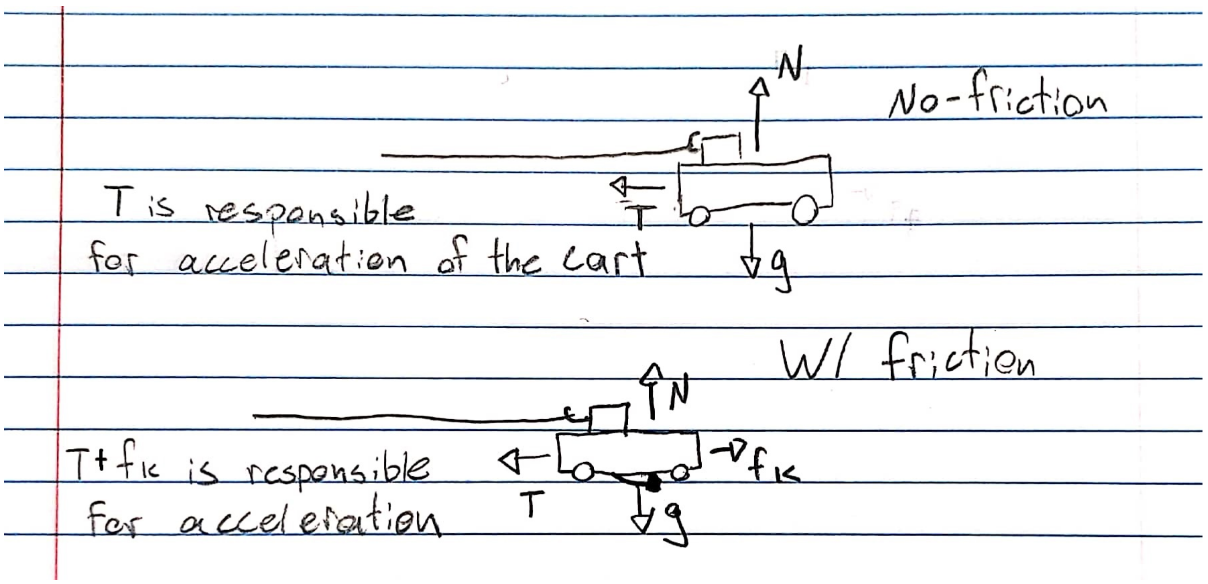
The lighter lines are the "no-friction" experiment.

8. For force, there seems to be little to no difference - although this may have been because of the inaccuracy of the recording device.

9. For velocity, there seems to be a slight advantage for the no-friction experiment which grows a small amount as it approaches the end.

10. For acceleration, there seems to be a very slight advantage for the no-friction experiment.

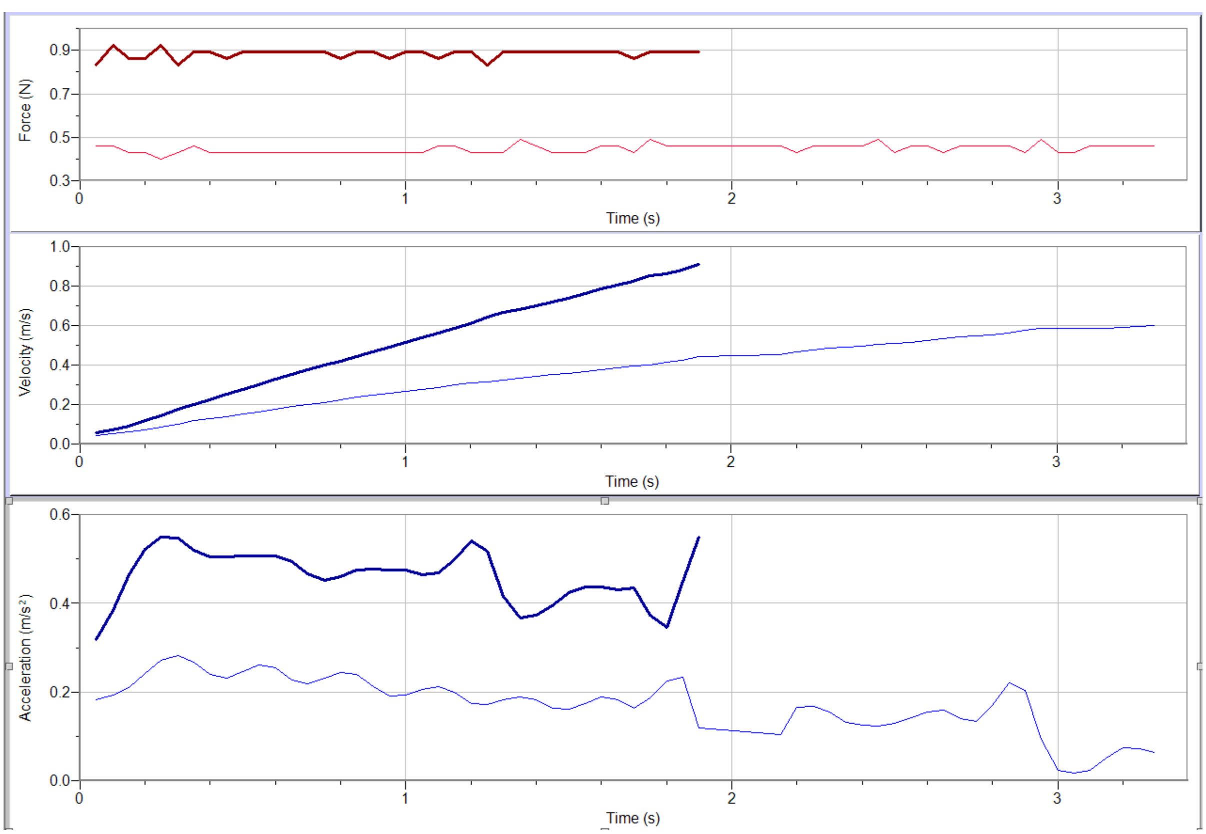
11.



12.

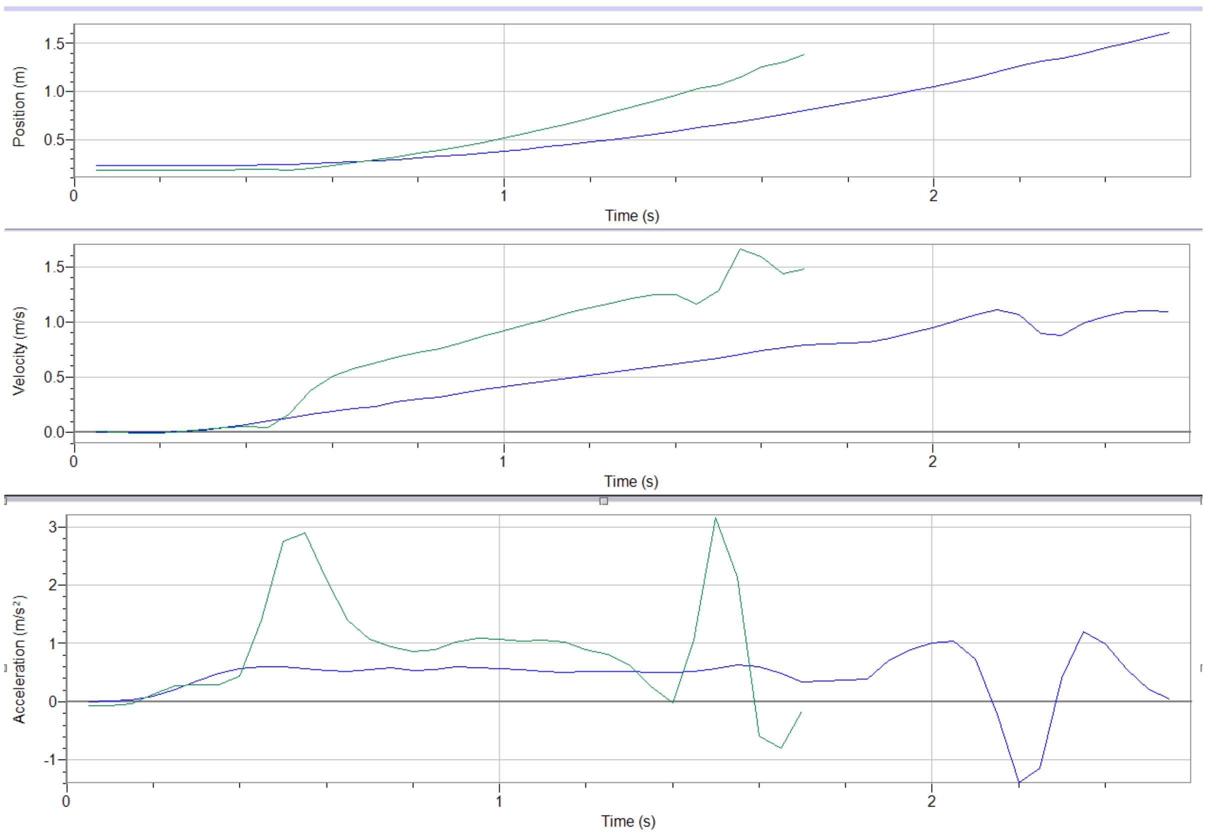
The acceleration will be doubled if the weight is doubled.

13.



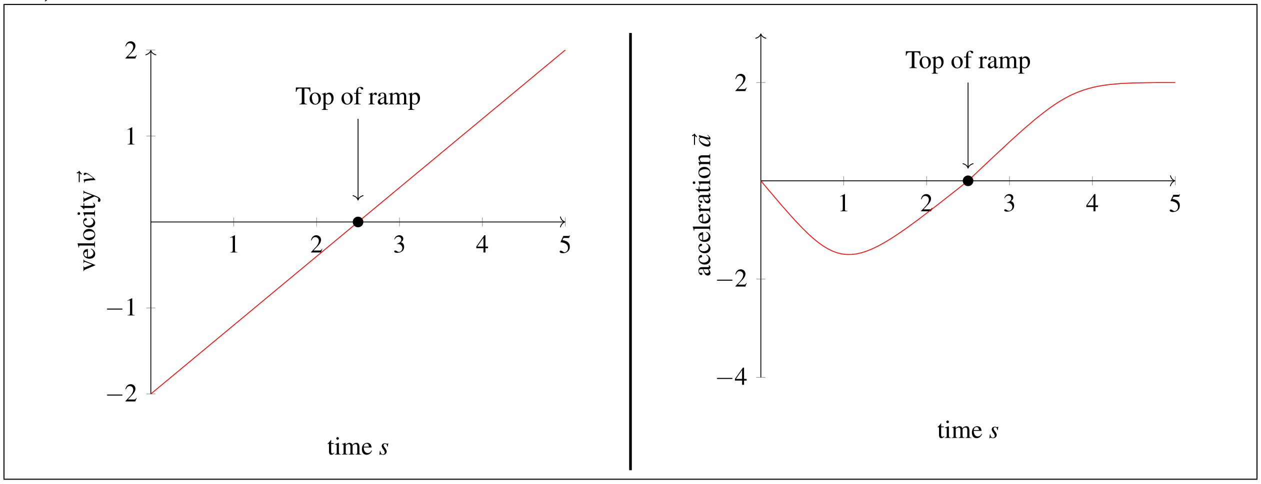
4: Velocity and acceleration of a cart on an inclined plane

14., 15.

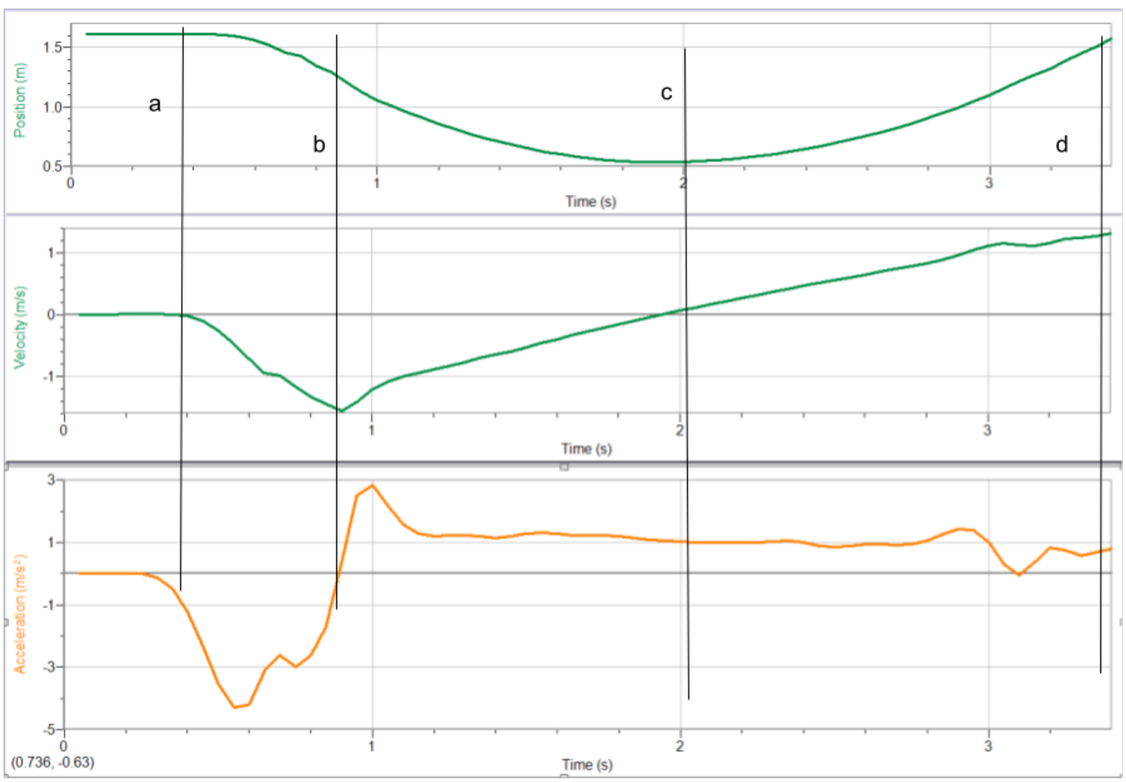


At a steeper slope, the acceleration was higher which resulted in the velocity and position having steeper slopes, this resulted in reaching the end of the ramp in $\sim 2/3$ the time of the shallower slope.

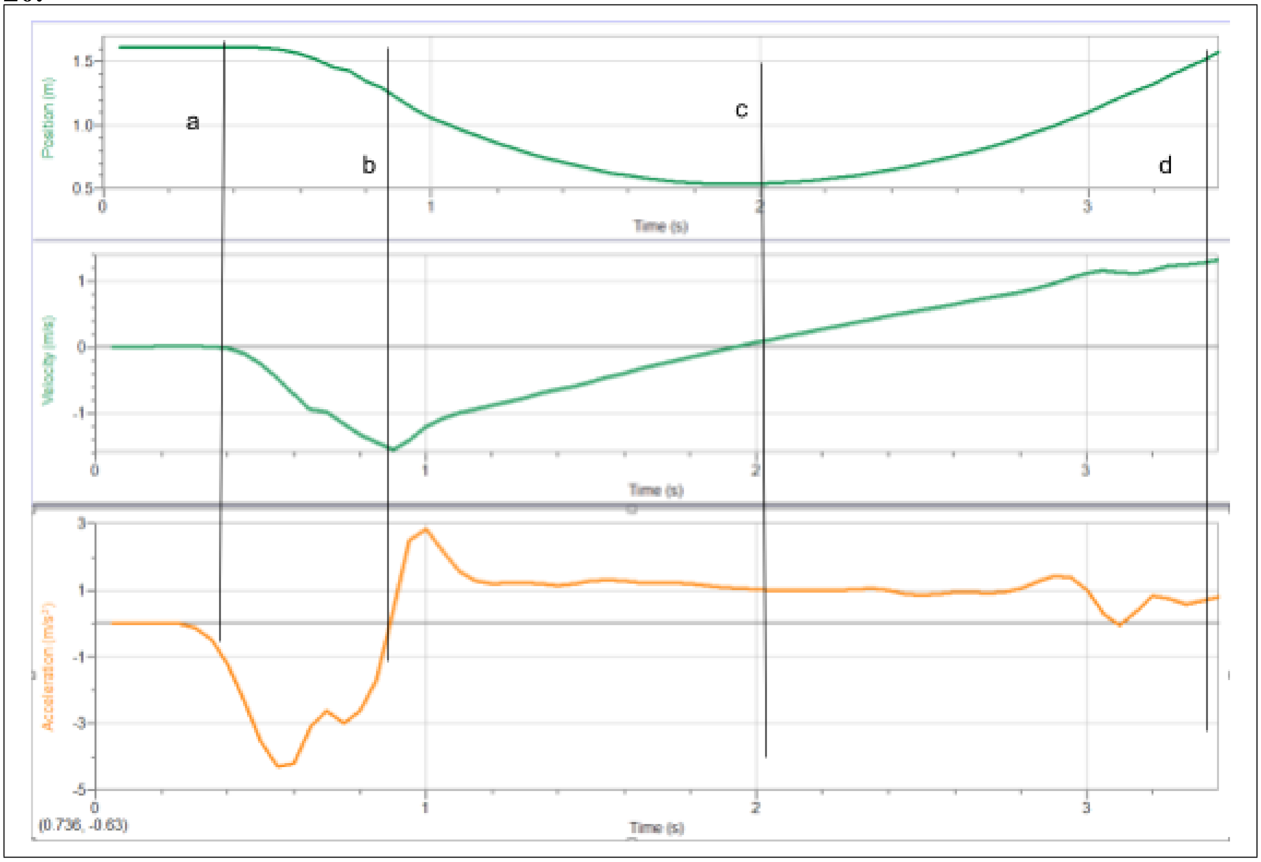
16., 17.


Top of ramp
velocity $\vec{v}$
time s
2
1
−1
−2
1 2 3 4 5
Top of ramp
acceleration $\vec{a}$
time s
2
−2
−4
1 2 3 4 5

18., 19.


Position (m)
Velocity (m/s)
Acceleration (m/s²)
Time (s)
a
b
c
d
(0.736, -0.63)

20.



Conclusion Questions

21.

Motion away is represented as a positive value. Speeding up is signified by a positive/negative slope to the velocity graph.

22.

The magnitude of the acceleration is the absolute value of the slope of the plot.

23.

The magnitude of the acceleration is represented as the absolute value of the acceleration vs time graph.

24.

The sign of the velocity is positive and the sign of the acceleration is negative because the cart is moving in the positive direction but accelerating in the negative direction.

25.

The force is relatively even but does have a slight peak towards the end of the ramp, probably due to the stopping of the cart.

26.

The force does not change with or without the friction pad, but the acceleration does. This is not a violation because there is an extra force being applied to the cart that isn't being detected by the probe - friction - that forces either the mass of the object or the acceleration to change according to $\sum F = m\vec{a}$ as the net force changes on the cart.

27.

The velocity shoots to a negative value and then returns on a linear path to a positive one; the acceleration shoots sharply down and then returns up to a positive constant. My graphs were pretty close but failed to capture the start-up of the velocity graph and the extra peaks/troughs of the acceleration graph.

28.

A. The average velocity on the way up is positive.

B. The acceleration on the way up is negative.

C. At the top, the velocity is zero.

D. At the top the acceleration is negative.

E. The velocity on the way down is negative.

F. The acceleration on the way down is negative.

G. When the ball's velocity and acceleration have opposite signs the ball is going up and when the velocity and acceleration have the same sign the ball is falling down.

29.

When the friction pad is down, it applies a force that will constantly affect the acceleration, especially while the cart is rolling down the ramp.