WPI | Department of Physics

Worksheet for Lab 4: Impulse Momentum

Name: Vinh Tran
Section: 14

Partner: Ananya Gopalan
Date: 09/26/19

Use this sheet to enter and submit your answers to the questions asked in the gray boxes on the Lab Instructions document. When you have completed this worksheet, save this file as a .pdf and upload the pdf to the canvas assignment associated with this lab. If you have any trouble converting to a pdf, please ask you Lab Instructor or Lab Assistant.

Remember to use complete sentences and that these text boxes will increase in size as you add more content.

Propagation of Uncertainty

Show your work for the propagation of uncertainty for each value. Use the word equation editor or paste a picture of your work here.

In [13]:
```
import statistics as stat


imean = .201 # Initial Velocity avg
istdevV = .0005 # Initial Velocity avg deviation

fmean = -.111 #  Final Velocity avg
fstdevV =.0005 #  Final Velocity avg deviation

deltaV= fmean-imean  #  change in Velocity
deltaVdev = fstdevV + istdevV #  change in Velocity deviation

print("uncertainty in change in velocity =",deltaVdev)
print("change in velocity =",deltaV)

Intforce = -.195 # Impulse from force
stdevF = .0005 # dev of Impulse from force
print("Impulse by force =",Intforce)



mass = .5 #mass of car in kg
devmass = .05 # dev of car mass

impulse = deltaV*mass
devimpulse = (devmass/mass)+(deltaVdev/deltaV)*mass*deltaV #deviation of impulse
print(" Impulse by velocity =",impulse)
print("uncertainty in impulse =",devimpulse)
```

```
uncertainty in change in velocity = 0.001
change in velocity = -0.312
Impulse by force = -0.195
 Impulse by velocity = -0.156
uncertainty in impulse = 0.1005
```

In [14]:
```
import statistics as stat


imean = .178 # Initial Velocity avg
istdevV = .0005 # Initial Velocity avg deviation

fmean = -.1474 #  Final Velocity avg
fstdevV =.0005 #  Final Velocity avg deviation

deltaV= fmean-imean  #  change in Velocity
deltaVdev = fstdevV + istdevV #  change in Velocity deviation

print("uncertainty in change in velocity =",deltaVdev)
print("change in velocity =",deltaV)

Intforce = -.179 # Impulse from force
stdevF = .0005 # dev of Impulse from force
print("Impulse by force =",Intforce)



mass = .5 #mass of car in kg
devmass = .05 # dev of car mass

impulse = deltaV*mass
devimpulse = (devmass/mass)+(deltaVdev/deltaV)*mass*deltaV #deviation of impulse
print(" Impulse by velocity =",impulse)
print("uncertainty in impulse =",devimpulse)
```

```
uncertainty in change in velocity = 0.001
change in velocity = -0.3254
Impulse by force = -0.179
 Impulse by velocity = -0.1627
uncertainty in impulse = 0.1005
```

In [15]:
```
import statistics as stat


imean = .161 # Initial Velocity avg
istdevV = .0005 # Initial Velocity avg deviation

fmean = -.102 #  Final Velocity avg
fstdevV =.0005 #  Final Velocity avg deviation

deltaV= fmean-imean  #  change in Velocity
deltaVdev = fstdevV + istdevV #  change in Velocity deviation

print("uncertainty in change in velocity =",deltaVdev)
print("change in velocity =",deltaV)

Intforce = -.158 # Impulse from force
stdevF = .0005 # dev of Impulse from force
print("Impulse by force =",Intforce)



mass = .5 #mass of car in kg
devmass = .05 # dev of car mass

impulse = deltaV*mass
devimpulse = (devmass/mass)+(deltaVdev/deltaV)*mass*deltaV #deviation of impulse
print(" Impulse by velocity =",impulse)
print("uncertainty in impulse =",devimpulse)
```

```
uncertainty in change in velocity = 0.001
change in velocity = -0.263
Impulse by force = -0.158
 Impulse by velocity = -0.1315
uncertainty in impulse = 0.1005
```

Based on the data that you took today, write and answer the questions in the following sections. Remember that even though you will have the same data as your partner, the writing in these sections should be done individually.

Experimental Method

- Position and zero the sensor to accurately record the movement of the car.
- Move the car at a constant velocity towards the force sensor to study the proper motion.
- Repeat motion but in slower velocities to ensure accuracy of the force sensor.
- Record and scale data to analyze relevant sections.
- Calculate the correct uncertainty for the recorded data.

Results

	Impulse By Force	Impulse By Velocity	Uncertainty of Velocity Impulse
Slow	0.195 N·s	0.156 kg·m/s	±0.1
Slower	0.179 N·s	0.163 kg·m/s	±0.1
Slowest	0.158 N·s	0.132 kg·m/s	±0.1

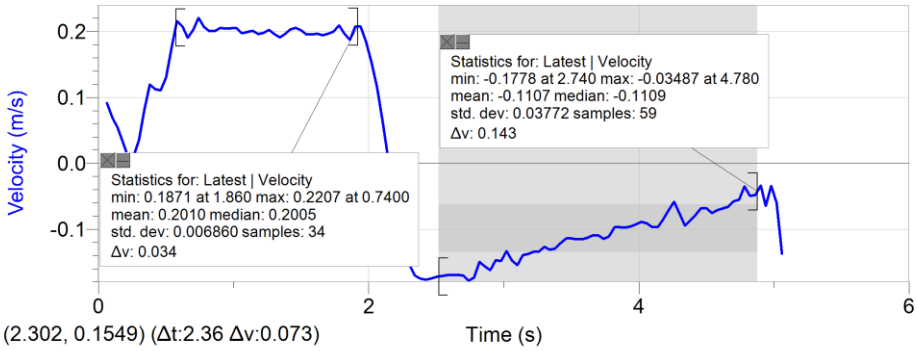


Figure 1: Slow Constant Velocity vs Time

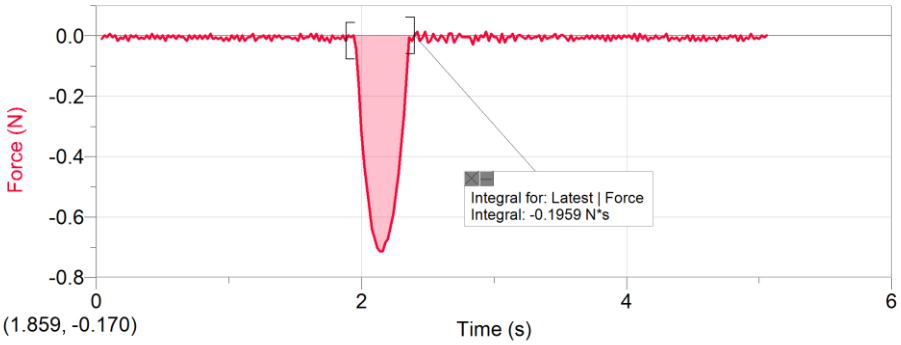


Figure 2: Slow Force vs Time Graph

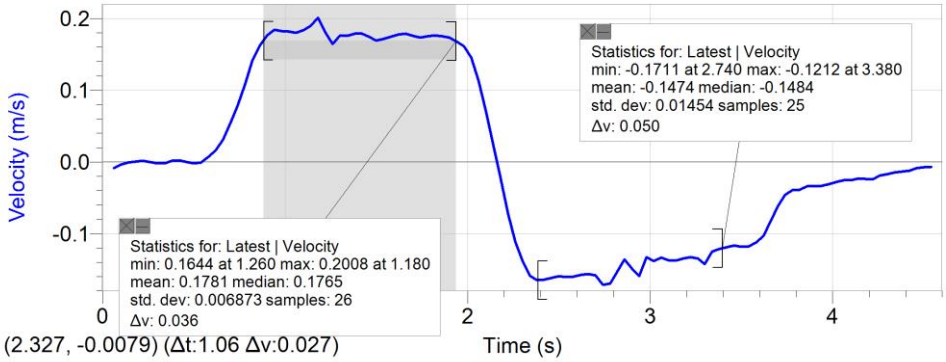
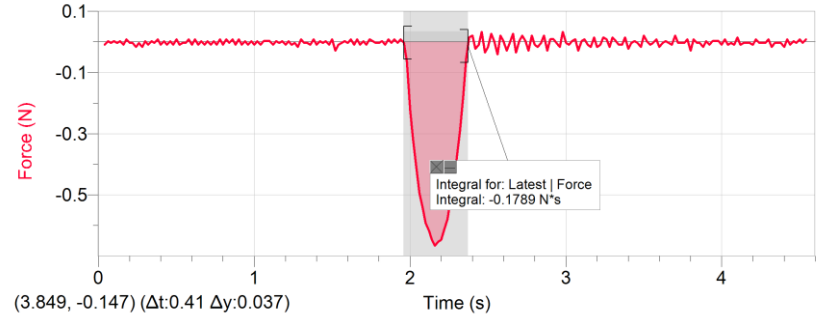


Figure 3: Slower Velocity v Time Graph



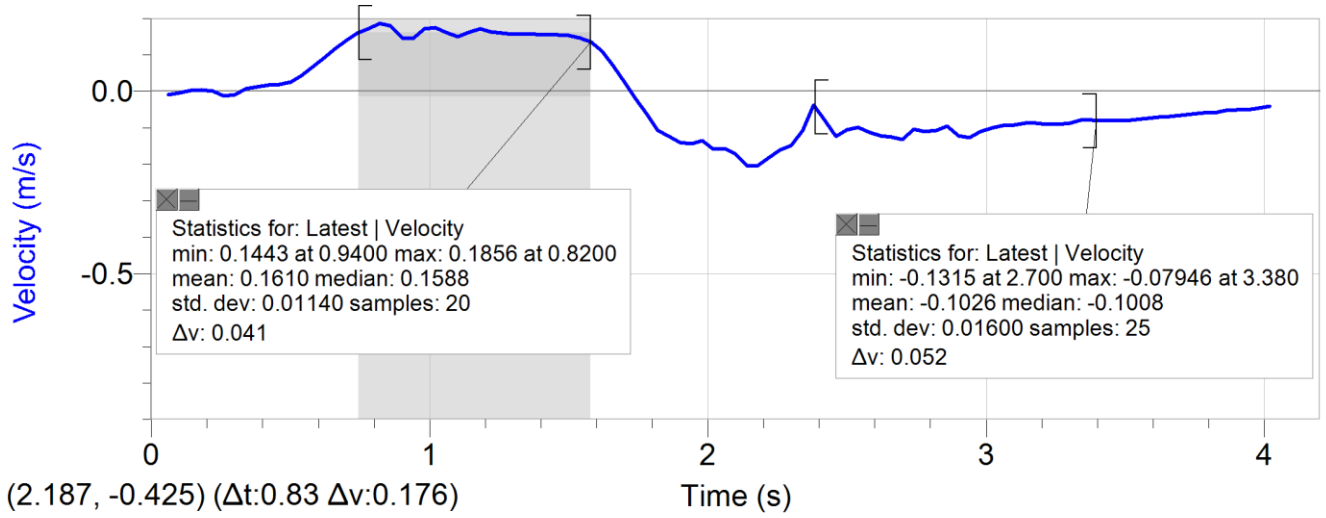


Figure 5: Slowest Velocity vs Time Graph

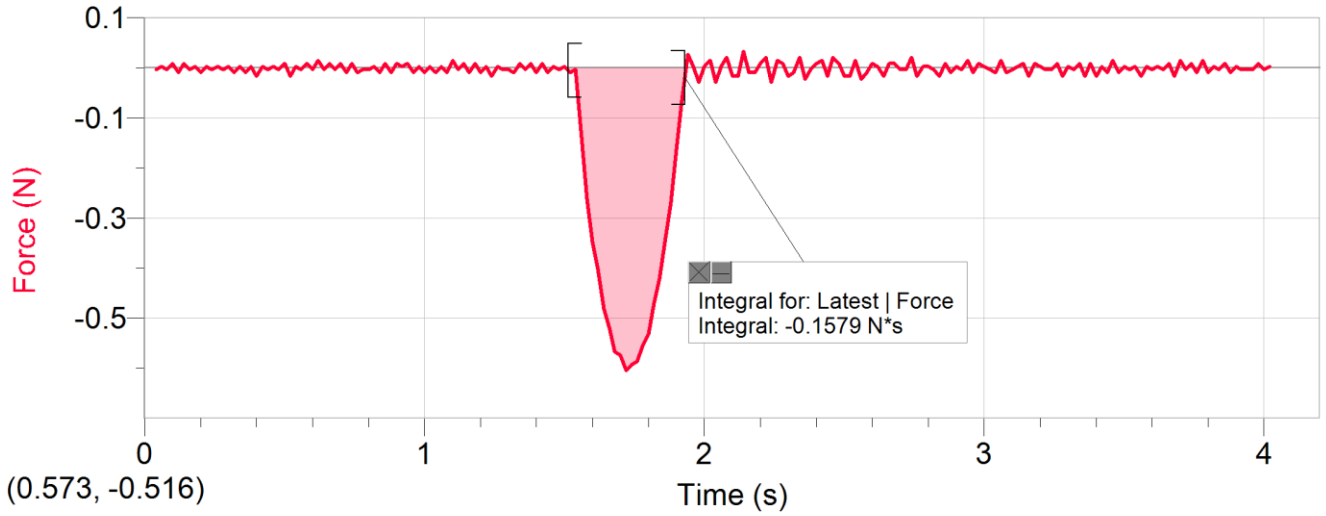


Figure 6: Slowest Force vs Time

Trial #	Impulse By Force	Change in Momentum	Uncertainty of Change in Momentum
Trial 1 (Slow const V)	0.195 N·s	0.156 kg·m/s	±0.1
Trial 2 (Slower const V)	0.179 N·s	0.163 kg·m/s	±0.1
Trial 3 (Slowest const V)	0.158 N·s	0.132 kg·m/s	±0.1

The impulse by force was largest for trial 1, then trial 2, and lastly trial 3. The slower the constant velocity, the lower the impulse by force. The change in momentum is supposed to be less than the impulse by force. Which can be seen from trial one, where the change in momentum is .156 kg·m/s and the impulse force was 0.195 N·s, trial two where the change in momentum is 0.163 kg·m/s, which is less than the impulse force 0.179 N·s, and lastly trial three were the change in momentum is 0.132 kg·m/s which is less than the impulse force of 0.158 N·s. The change in momentum does not increase as the velocity decreases, as expected, leading to a point of error.

Conclusion

The change in momentum equals the impulse force, as can be seen in tail one. The change in momentum is 0.156 kg·m/s ±0.1, and the impulse force (which is 0.195 N·s) is within that range. This holds true for different speed collisions. For trial two, the change in momentum is 0.163 kg·m/s ±0.1 and the impulse by force is 0.179 N·s, and within the change in momentum uncertainty. Similarly for trial 3, the change in momentum is 0.132 kg·m/s ±0.1 and the impulse force of 0.158 N·s is within that range. An interesting extension to this experiment would be to measure the impulse and momentum caused by two cars colliding into each other, after starting from opposite directions.

Graph and Data Checklist You should have six graphs with the appropriate title labels and a complete caption, answered all of the questions highlighted by the gray boxes and written a experimental methods, results, and conclusions section.