**Impulse and Momentum & Conservation of Momentum**

**Objective**

You will conduct a series of experiments that explore our first conservation law, conservation of momentum, and when the condition for using it is met.

**Report**:

Use this document as the template for your report. Turn in one group report. It must be word-processed. All graphs must be integrated into the text. You may include some hand-written comments.

**Background**

Conservation of linear momentum can be expressed as:



Momentum is conserved only if the *net force* on the system is zero, or .

If you want to properly apply this conservation law it is **crucial** that you choose your system such that it has no net force acting on it during the collision/explosion/interaction that you are investigating. If there *is* a non-zero net force on your system there will be an impulse and the momentum-impulse theorem applies.

**Notes on today’s LoggerPro setup**

You will be using two carts each of which has its own motion detector. Usually, the motion detector is set up to measure position as positive away from the detector. For your setup one motion detector works as usual (the one on the left), the other one is reversed and the zero point is set at the left detector. This means that both detectors will measure on the same x-axis! Ask your instructor if you have questions.

In all experiments LoggerPro is set up to display both the x-t and v-t graphs for both carts.

**Notation**

Cart on the left: cart 1 Cart on the right: cart 2

 mass of cart 1  mass of cart 2

 initial velocity of cart 1  initial velocity of cart 2

 final velocity of cart 1  final velocity of cart 2

 initial momentum of cart 1  initial momentum of cart 2

 final momentum of cart 1  final momentum of cart 2

**Before you do any of the activities make a prediction of what you expect.**

**Activity 1: (m1 = m2, cart 2 stationary, cart 1 is pushed against cart 2, magnetic carts)**

Let cart 2 (on the right) be stationary and give cart 1 (on the left) a push towards cart 2. Predict x-t and v-t graphs, then do the experiment.

Paste a graph of x-t and v-t here:

Fill out the table below (use your LoggerPro data as necessary):

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Questions:

1.1 Choose cart 1 to be your system.

Draw a FBD for your system during the collision.

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| --- |
|  |

Should momentum be conserved for your system? Why or why not?

Calculate the momentum of your system before and after the collision. Was momentum conserved?

1.2 Choose both carts to be your system.

Draw a FBD for your system during the collision.

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Should momentum be conserved for your system? Why or why not?

Calculate the momentum of your system before and after the collision. Was momentum conserved?

**Activity 2: (m1 with one extra weight, m2 no extra weight, cart 1 pushed against cart 2, cart 2 stationary, magnetic carts)**

Put one extra weight (the black ‘sticks’) on cart 1.

Let cart 2 (on the right) be stationary and give cart 1 (on the left) a push towards cart 2. Predict x-t and v-t graphs. How will cart 1 move after the collision? Conduct the experiment.

Paste a graph of x-t and v-t here.

Fill out the table below (use your LoggerPro data as necessary):

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Choose both carts to be your system. Should its momentum be conserved?

Calculate the momentum of your system before and after the collision. Was momentum conserved? If not, why not?

**Activity 3: (m1 no extra weight, m2 with one extra weight, both carts pushed towards each other, magnetic carts)**

Put one extra weight (the black ‘sticks’) on cart 2.

This time give both carts a push towards each other. Predict how both carts will move after the collision. Conduct the experiment.

Paste a graph of x-t and v-t here.

Fill out the table below (use your LoggerPro data as necessary):

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Choose both carts to be your system. Should its momentum be conserved?

Calculate the momentum of your system before and after the collision. Was momentum conserved? If not, why not?

**Activity 4: (m1 = m2 ,no extra weights, cart 2 stationary, cart 1 is pushed against cart 2, non-magnetic carts)**

In this activity you will analyze a completely inelastic collision. In this type of collision the objects will stick together after the collision. Put a piece of rolled-up electrical tape on cart 2. Do not use any extra weights. Use the **non**-magnetic carts.

Let cart 2 (on the right) be stationary and give cart 1 (on the left) a push towards cart 2. Predict x-t and v-t graphs. Conduct the experiment.

Choose the two carts to be your system. Do you expect momentum of your system to be conserved?

Paste a graph of x-t and v-t here.

Fill out the table below (use your LoggerPro data as necessary):

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Calculate the momentum of your system before and after the collision. Was momentum conserved? If not, why not?

**Activity 5: (only one cart, drop a weight on it while it is moving)**

Use only one cart for this experiment. Give it a push and drop a weight onto it (gently and vertically) as it is moving. Predict x-t and v-t graphs.

Choose both the weight and the cart to be your system.

Do you expect momentum to be conserved? Which component?

Paste a graph of x-t and v-t here.

Fill out the table below (use your LoggerPro data as necessary):

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Calculate the momentum of your system before and after the collision. Was momentum conserved?

Was momentum in the y-direction conserved in your system? If not, what should you choose as your system for py to be conserved?