PY 105

Section: **Name:** **BU ID:** **.**

Partner: **Name:** **BU ID:** **.**

Lab 6: Collisions

Part I. Go to the following link: http://physics.bu.edu/ulab/prelabs/prelab_collisions_new.html (the copy of the link is in file **py105labweblinks.doc**)

Start the simulation (click on SIMULATION; if needed, accept all security notification, try a different browser) and follow the instructions, however do **NOT** print out the screen, **enter your data into the tables below**.

Collision	Initial momentum of the blue cart	Initial momentum of the red cart	Final momentum of the blue cart	Final momentum of the red cart	Total initial momentum	Total final momentum	Ratio of total final/total initial
1							
2							
3							

Is total linear momentum of the system of two carts conserved in all these collisions?

_____

Collision	Initial KE of the blue cart	Initial KE of the red cart	Final KE of the blue cart	Final KE of the red cart	Total initial KE	Total final KE	Ratio of total final/total initial
1							
2							
3							

Is total _kinetic_ _energy_ of the system of two carts conserved in all these collisions?

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Is total _energy_ of the system of two carts conserved in all these collisions? Explain your answer

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Classify each of these collisions according to the definitions given in the lab write-up.

Collision 1: [ ] Super-elastic   [ ] Elastic   [ ] Inelastic   [ ] Completely inelastic

Collision 2: [ ] Super-elastic   [ ] Elastic   [ ] Inelastic   [ ] Completely inelastic

Collision 3: [ ] Super-elastic   [ ] Elastic   [ ] Inelastic   [ ] Completely inelastic

Part II. In this experiment you will use two carts on a track with a force sensor attached to each of the carts.
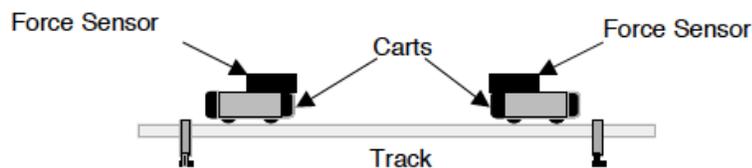
1. State the law of conservation of linear momentum.

2. The impulse of a force is equal to:

[　] $m*a$　　　[　] area under the graph $F(x)$　　　[　] area under the graph $F(t)$

Start file PY105_lab6_I.cmbl.

Make sure the switch on the force sensor is set to 50 N.
Zero all the sensor before collecting any data!

Every time when running an experiment you should click [▶ Collect] button and then make a collision. The software starts collecting data when the force 1 is greater than 0.1 N, and stops collecting data automatically after 0.2 seconds. Do not collide the carts too hard, the carts should not leave a track after the collision. Practice before collecting data.

On the screen you can see the graphs for two forces provided by the force sensors of the interacting carts (one blue graph and one red graph).

(Absolutely/ Completely) Inelastic Collision

3. Make sure that only *one* of the carts has a rubber bumper attached to the force censor (if needed, unscrew a bumper from one of the carts; **Attention**! *Do not lose bumpers and washers*!). **Make sure the bumper is not loose and sits tight in the force censor.** The second cart should have a small screw screwed in the force censor. Do not add any weight to either of the carts. Collide the carts, make sure that after the collision *the carts get stuck* to each other (after the collision the carts should form one object and move together), but the bumper should reach and hit the force sensor on the other cart. You may need to try the collision several times and adjust the length of the screw to insure it hits the bumper but does not prevent cars from sticking together; do not push the carts too hard.

Start collecting data and push one cart toward another one, which is initially at rest. Look at the graphs. What can you say about the magnitude and direction of the forces acting between the carts?

The magnitude:

_____

The direction:

_____

The mass of the cart with the sensor is 400 gram. Use your answers to questions 1 and 2, use your data and the law of conservation of linear momentum and estimate the speed of the *first* cart before the collision (hint: use IMT). Select on the graph the regions corresponded to the collision and with the means of the Integrate button, [☑] (click OK if asked a question), find the impulses acting on each cart during the collision (hint: what is the meaning of the area of F(T) graph?).

Conclude on the impulse transferred during the collision to the first cart from the second; b) to the second cart from the first.

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State the type of the collision you have conducted in part 3. Is the kinetic energy conserved in this collision? Prove your answer using your data.

4. Add a weight to one cart and repeat the collision with the light cart initially at rest.

Comment on the forces between the carts.

The magnitude:

_____

The direction:

Is the kinetic energy conserved in this collision? Prove your answer using your data.

5. Now, conduct the collision making both carts move towards each other. Comment on the forces between the carts.

The magnitude:

_____

The direction:

Is the kinetic energy conserved in this collision? Prove your answer using your data.

After conducting several *completely inelastic collisions* make a conclusion about the total *kinetic* energy of the system (conserved, increases, decreases?).

Elastic Collision

6. Add a bumper (with the washers, if needed) to another cart (point the bumpers toward each other). Use the carts with *different* masses (place an extra weight for one of the carts). What type of the collision do you expect to happen *now* (**neglect friction**)?

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Conduct the collision with one cart initially at rest. Select on the graph the regions corresponded to the collision and with the means of the Integrate button, ⊡ (click OK if asked a question), find the impulses each cart transfers to another one during the collision. Conclude on the impulse transferred during the collision (a) to the first cart from the second; (b) to the second cart from the first.

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Calculate the *magnitude* of the average force acting between the carts. Show your work below.

7. Conduct the collision with both carts moving towards each other. Select on the graph the regions corresponded to the collision and with the means of the Integrate button, ⊡ (click OK if asked a question), find the impulses each cart transfers to another one during the collision. Conclude on the impulse transferred during the collision (a) to the first cart from the second; (b) to the second cart from the first.

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Calculate the *magnitude* of the average force acting between the carts. Show your work below.

Make a general conclusion on the forces acting between two objects (Which law have you just proved?).

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8. Close file PY105_lab6_I.cmbl (do not save your data). Start file PY105_lab6_II.cmbl.

Now take off the track carts with force sensors (make sure there is no wire laying across the track), and place on the track to empty carts.

You will need to design and make two collision of your choice and compare *the momentum of the system* before and after the collision, as well as the kinetic energy of the system before and after the collision. The motion sensors attached to the track will give the graphs for the position of the carts as a function of time. You need to measure the masses of the carts (including the mass of the weight added to a cart, if added), start collecting data, make the carts collide, and use the information from the graphs to prove the law of conservation of linear momentum. Show your data and your work below.

Give a real life example of a collision, describe the situation from the point of view of the law of conservation of linear momentum, as well as explain what is happening to kinetic energy.

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Equipment

Lab 6 (12 tables): two plastic PASCO carts with force sensors (at least one with a *short* bumper), a track, a metal bar (or another weight), two motion sensors, a computer with an interface and Internet access, two empty PASCO carts.

PE 6: (12 tables): computers

Unit layout

L6: 120 minutes

Breaks when needed

PE6: 80 minutes

Practice Exercise 6 (80 minutes): Center of Mass.
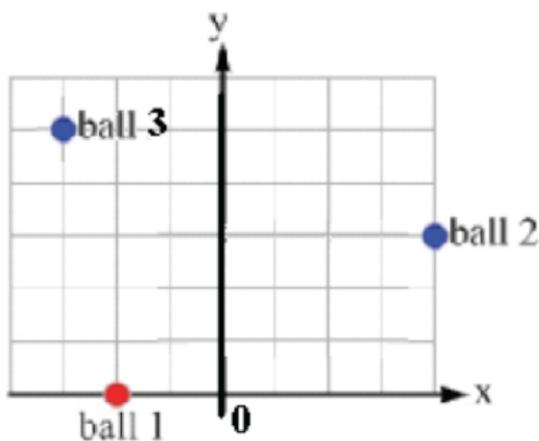
Section:_____   **Name:**_____

Use an Internet search to find the meaning of the term "center of mass of a system" and the expressions for calculating its coordinates. Write below the general expressions for x and y coordinates of a center of mass of a system composed of three objects.

X:

Y:

I. In the picture on the left, ball 2 is twice heavier of ball 1; ball 3 is three times heavier of the ball 1; each square of the grid has the size of 10 cm x 10 cm.
A) Find the X and Y coordinates of the center of mass of the system. Show CofM in the picture.
B) Describe what will be happening to CofM is the mass of ball 1 will be approaching 0 (but balls 2 and 3 keep their masses constant), find the location of CofM if the red ball is removed.
C) Describe what will be happening to CofM if the mass of ball 1 will be approaching infinity (ball 1 gets heavier and heavier, but balls 2 and 3 keep their masses constant).

(go to the next page)

Go to the following link: http://webphysics.davidson.edu/physlet_resources/bu_semester1/index.html

(the copy of the link is in file **py105labweblinks.doc**).

You will see on the left a list of applets, scroll down until you see Center-of-Mass and click on

Center-of-Mass

"Finding the center-of-mass" link (allow Java applet to run, if asked)

- Finding the center-of-mass

(if needed, accept all security notification, try a different browser).

When the applet is on, you will see a picture similar to the one on the right. Use the sliders (or enter numbers directly) and make the mass of ball 1 to be zero, or 100, and see what is happening to the center-of-mass of the system.

Does this "experiment" support your answers to parts (B) and (C)?