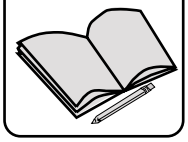
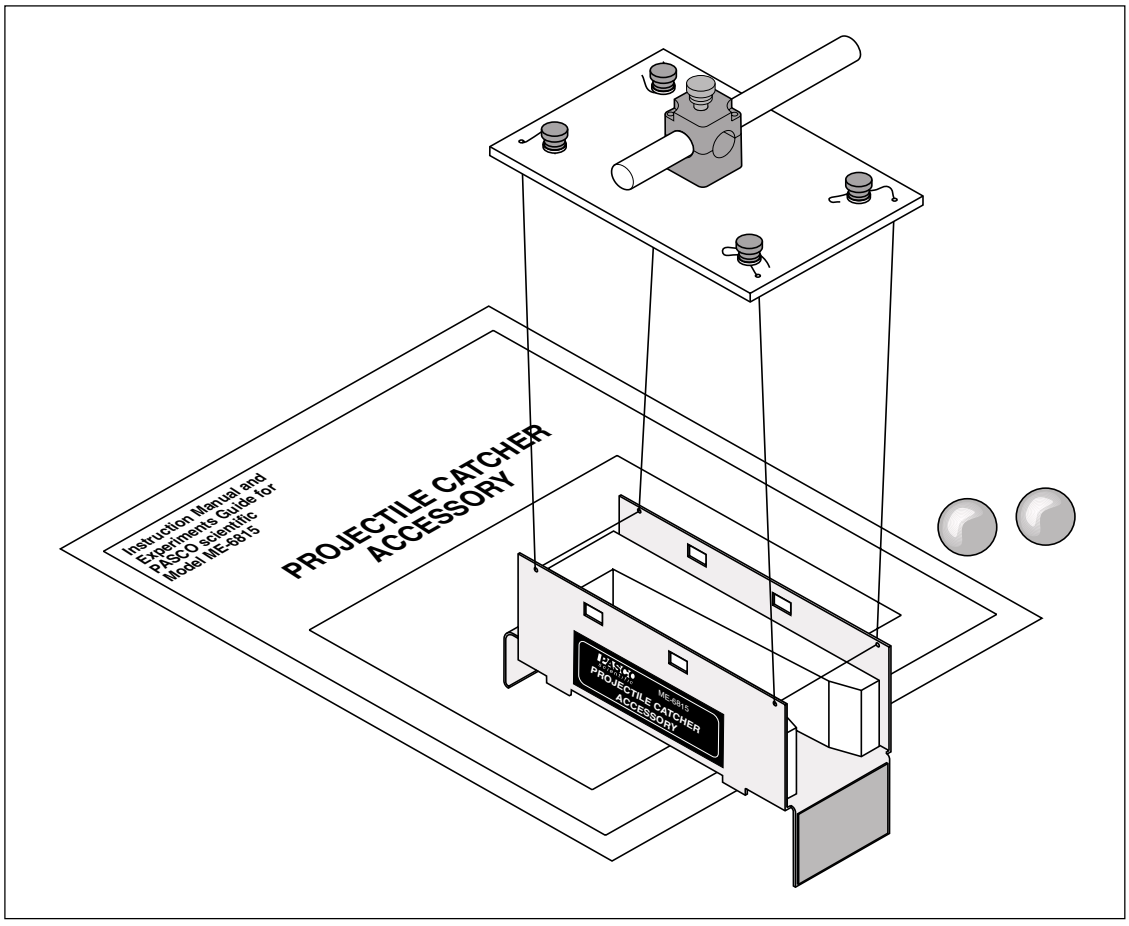
Includes
Teacher's Notes
and
Typical
Experiment Results



Instruction Manual and Experiment Guide for the PASCO scientific Model ME-6815

012-05091E
04/00

PROJECTILE CATCHER ACCESSORY



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The exclamation point within an equilateral triangle is intended to alter the user of the presence of important operating and maintenance (servicing) instructions in the literature accompanying the appratus.

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Copyright, Warranty, and Equipment Return

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① The packing carton must be strong enough for the item shipped.

② Make certain there are at least two inches of packing material between any point on the apparatus and the inside walls of the carton.

③ Make certain that the packing material cannot shift in the box or become compressed, allowing the instrument come in contact with the packing carton.

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Introduction

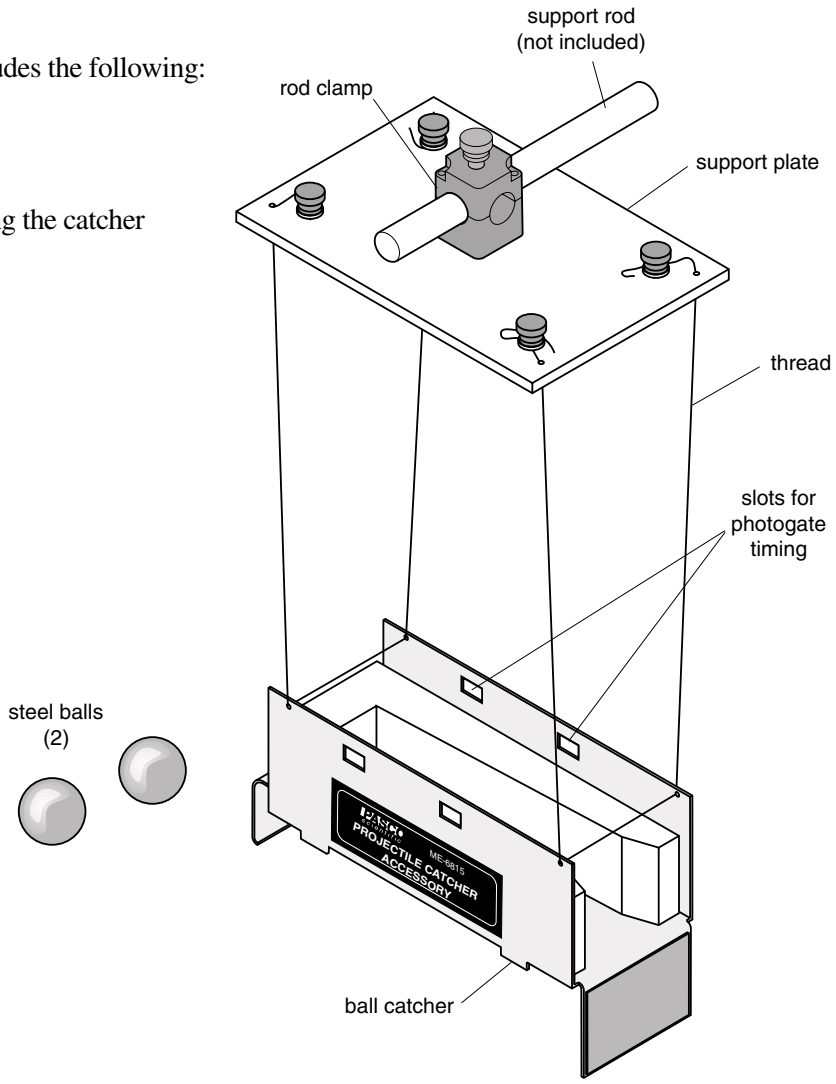
The PASCO ME-6815 Projectile Catcher Accessory has three functions:

- A Projectile Launcher is used to shoot a steel ball into the ball catcher which is mounted on a Dynamics Cart to show an inelastic collision.
- The steel ball can be bounced off the rubber bumper of the ball catcher to show an elastic collision between the ball and the cart.
- The catcher (without cart) can be suspended from strings and used with the Projectile Launcher as a ballistic pendulum.

Equipment

The Projectile Catcher Accessory includes the following:

- a ball catcher
- (2) steel projectile balls
- plate assembly from which to hang the catcher
- spool of thread
- Velcro® assembly



Projectile Launcher Setup

When using the Projectile Catcher Accessory with a PASCO ME-6800 or ME-6801 Projectile Launcher, follow these operation guidelines:

1. Please read the General Operations section of the *Projectile Launcher Manual* before using the Projectile Launcher with the Projectile Catcher Accessory or any other accessory.

   Safety goggles are supplied with the Projectile Launcher and must be worn when operating the apparatus.

2. The base of the Projectile Launcher must be clamped to a sturdy table using the clamp of your choice. When clamping to the table, it is desirable to have the label side of the launcher even with one edge of the table so a plumb bob can be used to locate the position of the muzzle with respect to the floor.

3. Mount the Projectile Launcher in a horizontal position, using the two lower slots in the Projectile Launcher base, as shown in Figure 1.

4. Establish the height at which the Projectile Launcher should be fired and tighten the thumbscrews as required.

WARNING: Never look down the front of the barrel of the Projectile Launcher because it may be loaded.

To check to see if the ball is in the barrel and whether the Projectile Launcher is cocked, look at the slots in the side of the barrel. The yellow indicator seen through the slot indicates the position of the piston and the ball can be seen through these slots when it is in the piston.

Wear safety goggles for eye protection.

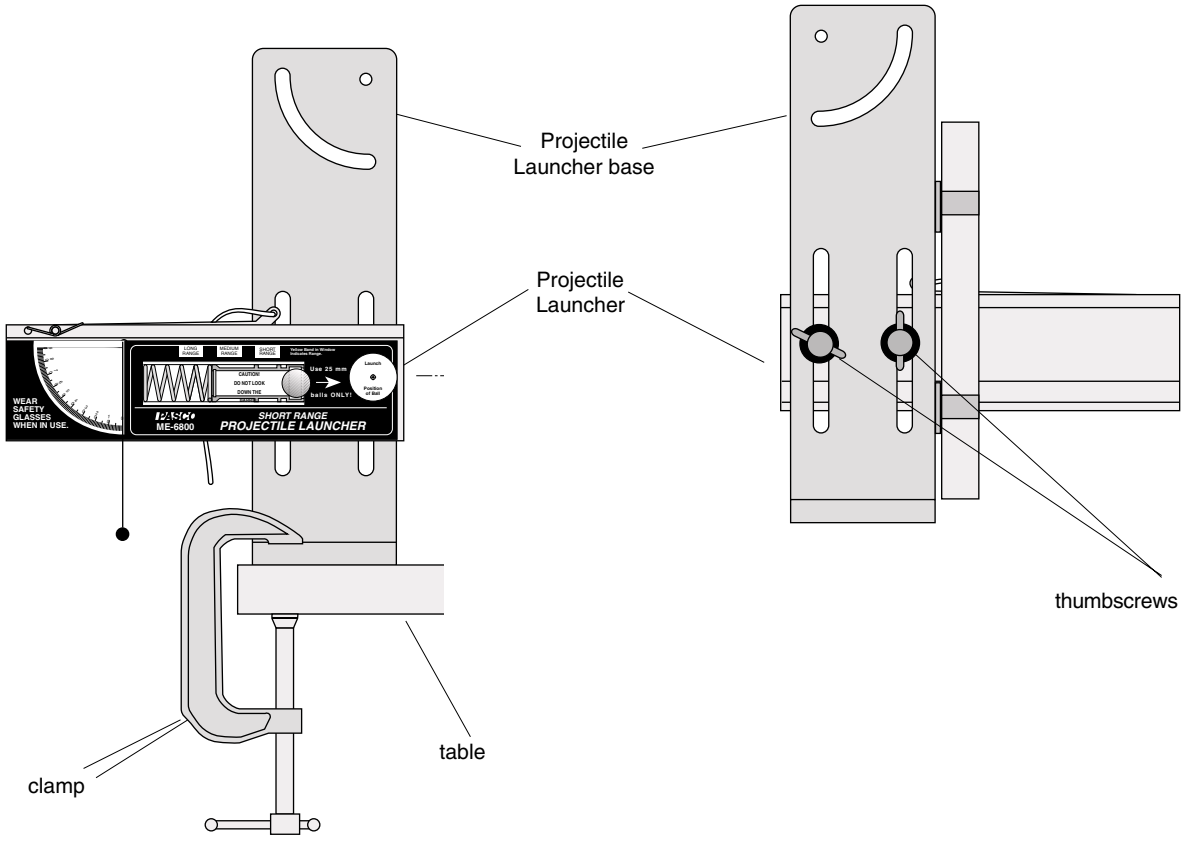


Figure 1: Projectile Launcher Setup

Ball Catcher Setup

Suspending the Ball Catcher as a Pendulum

Secure the rod clamp on top of the support plate to a support rod that is clamped to the table. Cut two pieces of string, each about two meters long. Thread one string through the front two holes in the ball catcher. Thread the other string through the back two holes in the ball catcher. Refer to the diagram below on how to attach the string. Thread the ends of the strings through the holes in the support plate and secure them, making sure the catcher hangs level.

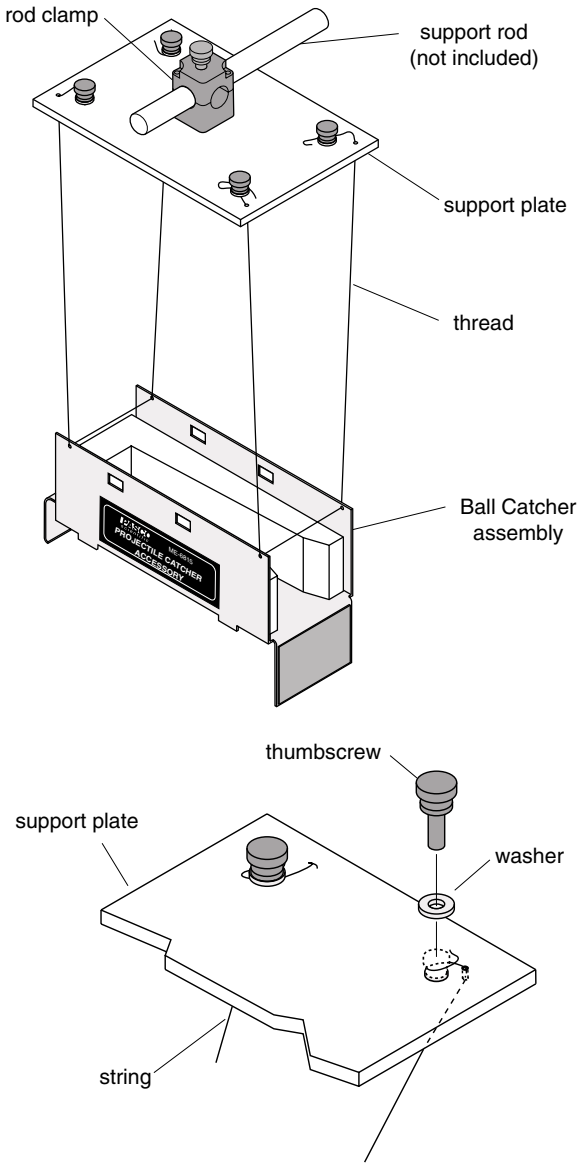


Figure 2: Suspending the Ball Catcher

Velcro Assembly

You may want to quantify and record the results of your experiments. To enable the user to measure the height to which the pendulum swings, a thread must be connected between the ball catcher and the launcher. The launcher end slips through a Velcro assembly, and the amount of extension of the string shows how far the pendulum swung. See Figure 3.

1. Separate the Velcro hook and loop strips.
2. Cut two square pieces of Velcro loop and one square piece of Velcro hook.
3. Determine the approximate height at which the Velcro assembly will be applied. This is determined by the approximate height at which the ball catcher hangs.
4. Remove the protective covering from the back of each Velcro square.
5. Arrange the two square pieces of Velcro loop and one square piece of Velcro hook onto the vertical plate of the Projectile Launcher base as shown.
6. Cut one piece of Velcro hook 5 – 6 cm long. Do not remove the protective backing.
7. Tie a thread to one of the front holes in the ball catcher.
8. The other end of this thread will pass between the square piece of Velcro hook (attached to the Projectile Launcher base) and the long piece of Velcro hook, which should be applied to the three Velcro squares attached to the Projectile Launcher base.

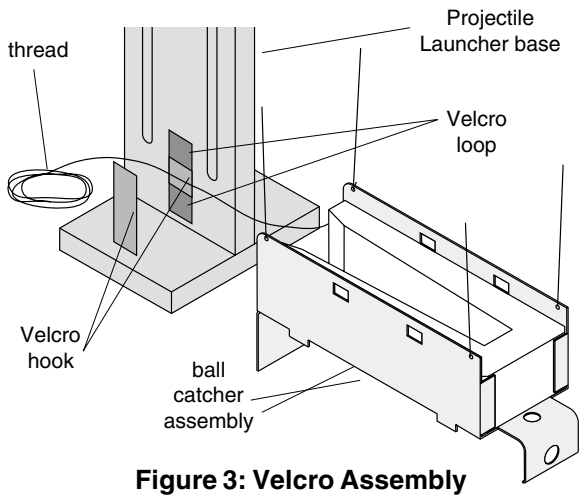


Figure 3: Velcro Assembly

Using the Ball Catcher with the Dynamics Cart

Some experiments require the ball catcher be attached to the PASCO ME-9430 Dynamics Cart (Plunger Cart).

1. Hook the rear lip of the ball catcher under the rear end cap of the Dynamics Cart. The spring plunger on the cart must be in the cocked position. (Note the orientation of the ball catcher. See Figure 4.)
2. Slip the ball catcher onto the Dynamics Cart. A hole in the ball catcher should slip over the trigger of the cart. The tabs on the sides of the ball Catcher fit on the outside of the cart tray.
3. Activate the Dynamics Cart's spring plunger trigger so the cart plunger catches the front lip of the ball catcher. See Figure 4.

To remove the ball catcher from the Dynamics Cart, cock the cart plunger by inserting a pen cap or the eraser end of a pencil into the hole provided on the front lip of the ball catcher.

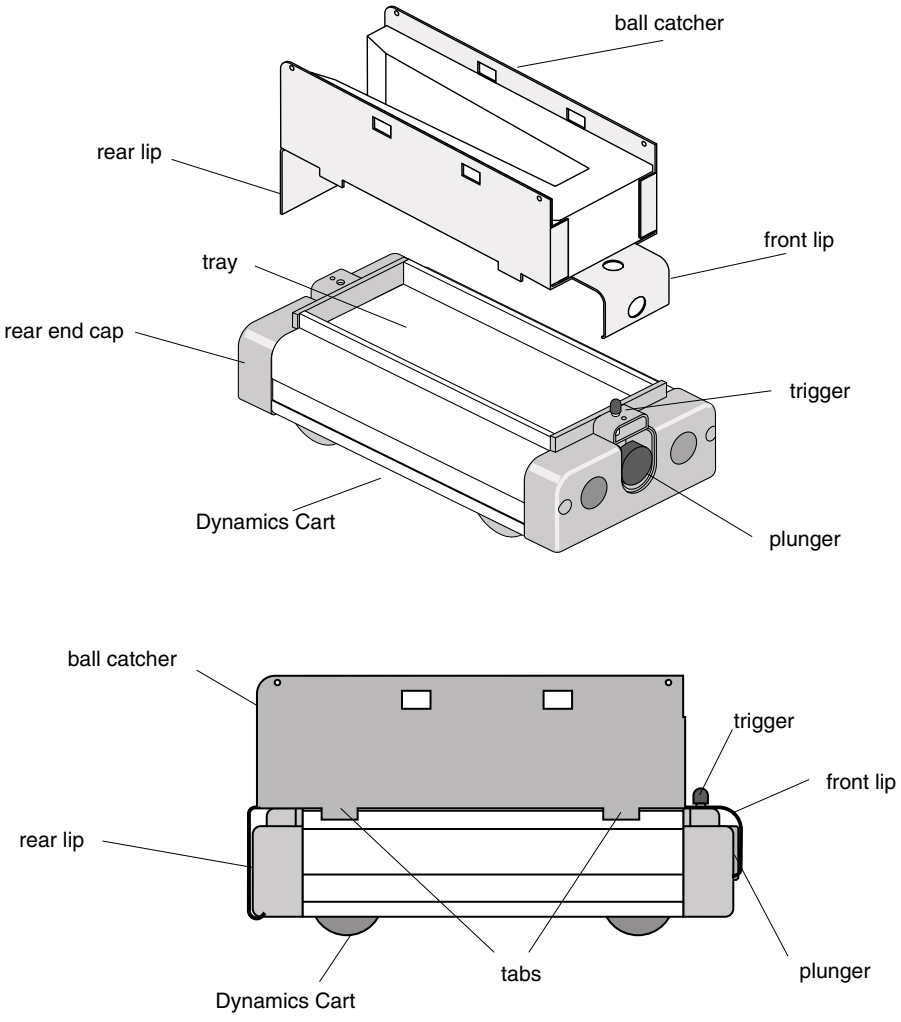


Figure 4: Mounting the Ball Catcher to the Dynamics Cart

Exp 1: Ballistic Pendulum

EQUIPMENT NEEDED

- Projectile Launcher (ME-6800)
- Projectile Catcher Accessory (ME-6815) [Velcro must be assembled (See Figure 3)]
- Base and Support Rod (ME-9355)
- table clamp
- -meter stick
- -white paper
- -carbon paper
- -mass balance

Optional: Photogates and Photogate Bracket

Purpose

The muzzle velocity of the Projectile Launcher can be determined by shooting the ball into a ballistic pendulum and then measuring the height reached by the pendulum.

Theory

A ball is launched horizontally and embeds in the bob of a pendulum. The pendulum then swings up to a particular height, h. (See Figure 1.1.)

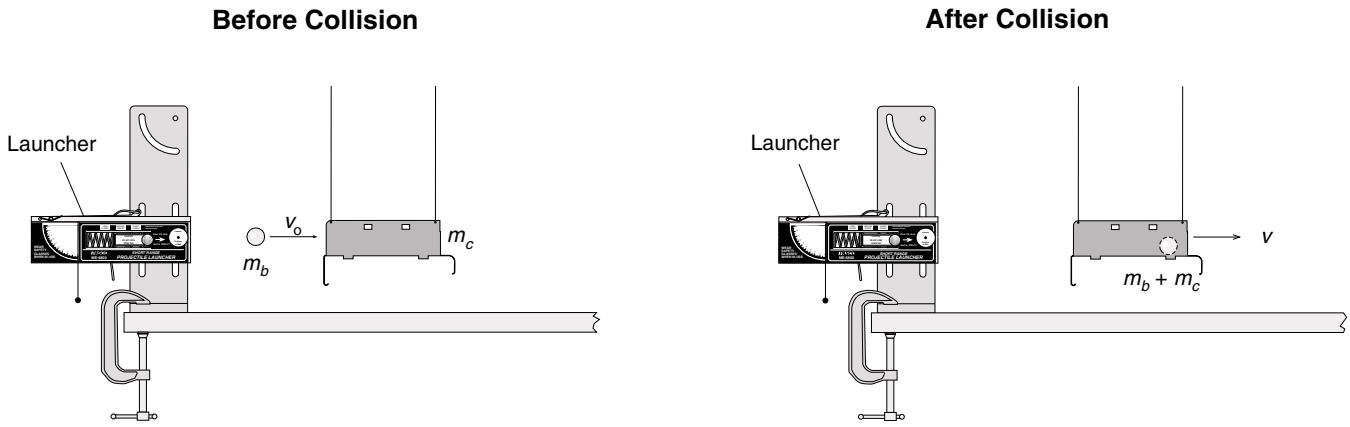


Figure 1.1: Conservation of Momentum

Momentum is conserved during the collision, but kinetic energy is not. The momentum after the collision is equal to the momentum before the collision:

$$(1) \quad m_b v_o = (m_b + m_c)v$$

where m_b is the mass of the ball, v_o is the muzzle velocity of the ball, m_c is the mass of the catcher, and v is the velocity of the catcher (and ball) after the collision.

The kinetic energy of the catcher (and ball) after the collision is converted completely to potential energy at the top of the swing:

$$(2) \quad \frac{1}{2}(m_b + m_c)v^2 = (m_b + m_c)gh$$

To find the muzzle velocity of the ball, we begin with the potential energy of the pendulum at the top of its swing and work backwards from there. From our equation for energy conservation (2):

(3) $v = \sqrt{2gh}$

Substitute (3) into the equation for momentum conservation (1):

$$m_b v_o = (m_b + m_c)\sqrt{2gh}$$
$$v_o = \left(\frac{m_b + m_c}{m_b}\right)\sqrt{2gh}$$

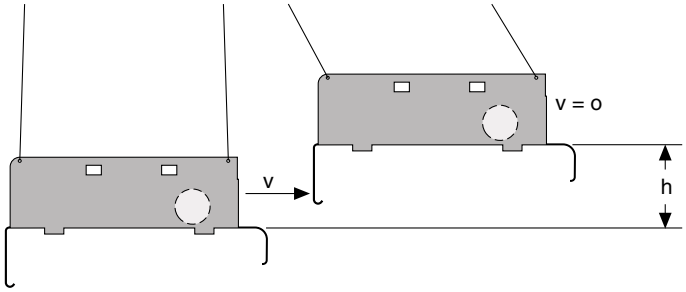


Figure 1.2: Conservation of Energy

For comparison, the initial speed (muzzle velocity) of the ball is determined by shooting the ball horizontally off the table onto the floor and measuring the vertical and horizontal distances through which the ball travels.

For a ball shot horizontally off a table with an initial speed, v_0, the horizontal distance ("x") traveled by the ball is given by $x = v_0 t$, where t is the time the ball is in the air. Air friction is assumed to be negligible.

The vertical distance the ball drops in time t is given by $y = \frac{1}{2}gt^2$.

The initial velocity of the ball can be determined by measuring *x* and *y*. The time of flight of the ball can be found using

$$t = \sqrt{\frac{2y}{g}}$$

and then the muzzle velocity can be found using $v_o = \frac{x}{t}$.

Part I: Determining the Initial Velocity of the Ball

Set Up

1. Clamp the Projectile Launcher to a sturdy table (near one end of the table).
2. Adjust the angle of the Projectile Launcher to zero degrees so the ball will be shot off horizontally, away from the table onto the floor.

Procedure

1. Put the steel ball into the Projectile Launcher and cock it to the long range position. Fire one shot to locate where the ball hits the floor. At this position, tape a piece of white paper to the floor. Place a piece of carbon paper (carbon-side down) on top of this paper and tape it down. When the ball hits the floor, it will leave a mark on the white paper.
2. Fire about ten shots.

3. Measure the vertical distance from the bottom of the ball as it leaves the barrel (this position is marked on the side of the barrel) to the floor. Record this distance in Table 1.1.
4. Use a plumb bob to find the point on the floor that is directly beneath the release point on the barrel. Measure the horizontal distance along the floor from the release point to the leading edge of the paper. Record in Table 1.1.
5. Measure from the leading edge of the paper to each of the ten dots and record these distances in Table 1.1.
6. Find the average of the ten distances and record in Table 1.1.
7. Using the vertical distance and the average horizontal distance, calculate the time of flight and the initial velocity of the ball.

   Record in Table 1.1 and Table 1.4.

Table 1.1: Determining the Initial Velocity

Vertical distance = _____.

Horizontal distance to paper edge = _____.

Initial velocity = _____.

Trial Number	Distance
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Average	
Total Distance	

Alternate Method: Determining the Muzzle Velocity with Photogates

1. Attach the Photogate Bracket to the launcher and attach two Photogates to the bracket. Plug the Photogates into a computer or other timer.
2. Put the ball into the Projectile Launcher and cock it to the long range position.
3. Run the timing program and set it to measure the time between the ball blocking the two Photogates.
4. Shoot the ball three times and take the average of these times. Record in Table 1.2.
5. Use a distance of 10 cm (between the Photogates) to calculate the initial speed. Record the initial speed in Table 1.2 and Table 1.4.

Table 1.2: Initial Speed Using Photogates

Trial Number	Time
1	
2	
3	
Average Time	
Initial Speed	

Part II: Ballistic Pendulum

Set Up

1. Find the masses of the ball and catcher. Record in Table 1.3.
2. Suspend the ball catcher as a pendulum, as explained in the general instructions.
3. With the Projectile Launcher mounted as in Figure 1.1, clamp the suspended ball catcher directly in front of the muzzle.
4. Attach a thread to the ball catcher and string it through the Velcro assembly (see the general instructions) on the base of the Launcher.

Procedure

1. Load the Launcher (set to long range) with the steel ball. Fire a test shot to see how far out the thread is pulled. Pull a few centimeters of the thread back through the Velcro, leaving the rest of the thread slack between the Launcher and the catcher. When the ball is shot into the pendulum again, the thread will become taut just before the catcher reaches its maximum height. This reduces the effect of friction on the thread.
2. Fire the ball into the pendulum five times. After each trial, pull the pendulum back until the thread is taut and measure the height above the level of the muzzle to which the pendulum swung. Record in Table 1.3.

Analysis

1. Calculate the average of the heights in Table 1.3. Record the result in Table 1.4. Using the average height, calculate the velocity immediately after the collision and record it in Table 1.4.
2. Using the velocity calculated in the previous step and the masses, calculate the muzzle velocity of the ball and record in Table 1.4.
3. Calculate the percent difference between the muzzle velocities found in Parts 1 and 2. Record in Table 1.4.

Table 1.3: Ballistic Pendulum Data

Mass of Ball = _____.

Mass of Catcher = _____.

Height

Table 1.4: Results

Average Height	
Velocity, v	
Calculated Muzzle Velocity, v_o	
Muzzle Velocity (Part 1)	
% Difference	

Questions

1. What percentage of the kinetic energy is lost in the collision? Use the masses and velocities to calculate this percentage:

$$\%Lost = \frac{KE_{before} - KE_{after}}{KE_{before}} \; x \; 100\%$$

2. How does the height to which the pendulum swings change if the ball is bounced off the rubber bumper on the front of the catcher instead of being caught?

   Try it, but be sure to move the catcher farther away from the Launcher so the steel ball won't rebound into the Launcher and damage the Launcher.

Exp. 2: Conservation of Momentum in an Inelastic Collision

EQUIPMENT NEEDED

– Projectile Launcher (ME-6800)
– Projectile Catcher Accessory (ME-6815)
– computer photogate timing system (such as Series 6500, or *Science Workshop*™)
– timing program*
– (3) Photogates (ME-9498)
– Photogate Bracket for Launcher (ME-6821)
– Dynamics Track (ME-9435A)
– Dynamics Cart (ME-9430)
– Photogate Bracket for Dynamics Track

➤ **NOTE:** For timing systems with only two photogate capacity, use the PASCO Four-to-One Adaptor (CI-6820) to accommodate 3 photogates, and use the "Motion Timer" data collection choice.
**Precision Timer, IDS Timer, Smart Pulley Timer, DataStudio™ or Science Workshop®.*

Purpose

The purpose of this experiment is to show that during an inelastic collision, momentum is conserved and energy is not conserved.

Theory

A ball is launched horizontally and embeds in the catcher mounted on the dynamics cart. See Figure 2.1.

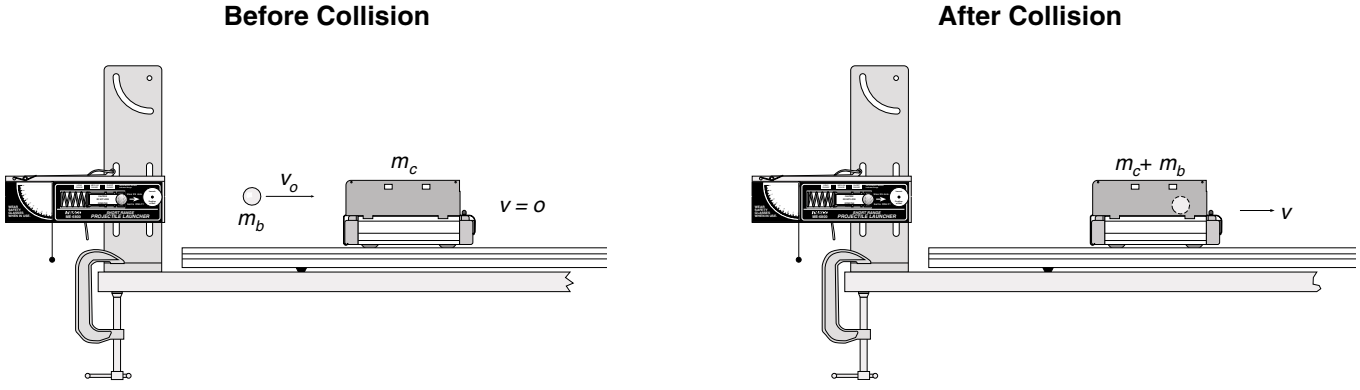


Figure 2.1: Conservation of Momentum

Momentum is conserved during the collision, but energy is not conserved. The momentum before the collision is equal to the momentum after the collision:

$$P_{before} = P_{after}$$
$$m_b v_o = (m_b + m_c) v_c$$

where m_b is the mass of the ball, v_o is the muzzle velocity of the ball, m_c is the mass of the catcher and cart, and v is the velocity of the cart and ball immediately after the collision.

The initial speed (muzzle velocity) of the ball is determined using two photogates mounted on the Launcher, and the final speed of the cart is found using a photogate mounted on the track.

Setup

1. Clamp the Projectile Launcher to a sturdy table (near one end of the table with the muzzle end facing inward toward the table).
2. Attach the photogate bracket to the Launcher, and attach two photogates to the bracket. Plug the photogates into the computer photogate timing system (or the Four-to-One Adapter). The photogate nearest the muzzle has to be plugged into port number one since the ball will go through it first.
3. Place the dynamics track on the table with one end against the base of the launcher. Mount the Projectile Launcher in the lower two slots on its base. Align the track with the launcher

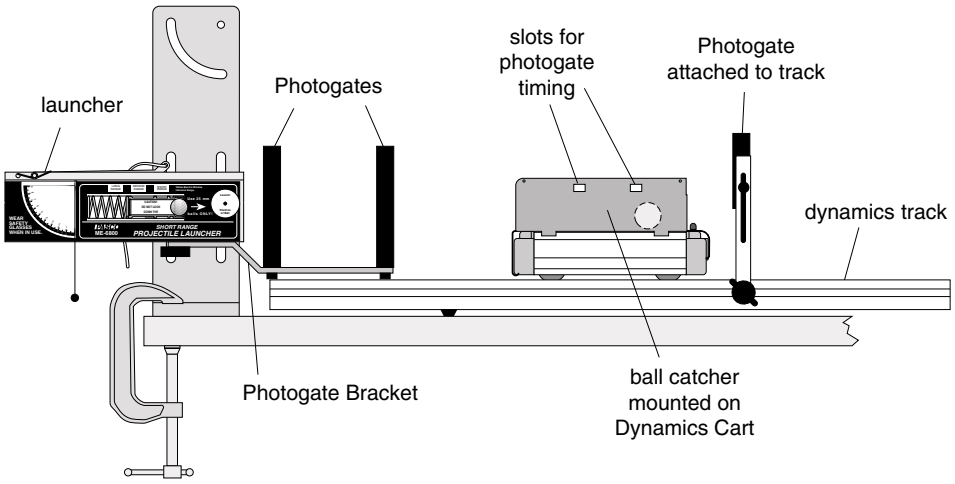


Figure 2.2: Track Set-Up

by sighting through the launcher sites at the far end of the track. See Figure 2.2. The track must be aligned with the launcher so the ball pushes the cart straight down the track without derailing it.

4. Adjust the angle of the Projectile Launcher to zero degrees so the ball will be shot off horizontally. Mount the catcher on the cart. Place the cart on the track at the end nearest the Launcher with the opening of the catcher facing the Launcher. Adjust the height of the Launcher so the ball will be shot into the center of the catcher.
5. Position a photogate on the track so the cart will block the beam immediately after the collision with the ball. The initial position of the cart should be as close to the Launcher's photogate bracket as possible. Adjust the height of the photogate so the infrared beam will pass through the slots in the side of the catcher.
6. Run the timing program, and set it to measure the gate and pulse time between three photogates. If the Four-to-One Adaptor is being used, use Motion Timer.

Procedure

1. Find the mass of the steel ball and the mass of the cart with catcher. Record in Table 2.3.
2. Put the ball into the Projectile Launcher and cock it to the long range position. Put the cart on the track directly in front of and as close as possible to the photogate bracket on the Launcher.
3. Shoot the ball three times and take the average of these times. Record in Table 2.1 or Table 2.2, depending on which timing mode is being used.

Table 2.1: Timing Data Using Gate-Pulse Mode

Trial Number	Time Between Gates 1 and 2	Time Gate 3 is Blocked
1		
2		
3		
Average Time		

Table 2.2: Timing Data Using Motion Timer

Trial Number	Time Between Gates 1 and 2	Time Between Blockings of Gate 3
1		
2		
3		
Average Time		

Analysis

1. Use a distance (between the photogates on the Launcher) of 10 cm to calculate the initial speed of the ball and record it in Table 2.3.
2. Calculate the final speed of the cart. If the Gate-Pulse mode was used, the distance for the cart is 4 cm, the length of the flag that blocked the third photogate. If the Motion Timer mode was used, the distance is 5 cm, the distance from leading edge to leading edge. Record the final speed in Table 2.3.

Table 2.3: Results

	Initial	Final	% Difference
Speed			
Momentum			
Kinetic Energy			

3. Calculate the initial and final momentum and record in Table 2.3.
4. Calculate the percent difference between the initial and final momentum. Record in Table 2.3.

5. Calculate the initial and final kinetic energy. Record in Table 2.3.
6. Calculate the percentage of the initial kinetic energy that is lost during the collision. Record in Table 2.3.

Questions

1. Was momentum conserved in the inelastic collision?
2. Was kinetic energy conserved in the inelastic collision?

DEMONSTRATION: Inelastic/Elastic Collisions

EQUIPMENT NEEDED

– Projectile Launcher (ME-6800)
– Projectile Catcher Accessory (ME-6815)
– Dynamics Track (ME-9435A)
– Dynamics Cart (ME-9430)

Purpose

The purpose of this demonstration is to show that the final cart speed during an *elastic* collision between the steel ball and the cart is *twice the final cart speed* of that during an *inelastic* collision between the steel ball and the cart.

Theory

Inelastic Collision

A ball is launched horizontally and embeds in the catcher mounted on the dynamics cart. The cart and ball then move off at a constant velocity. See Figure 3.1.

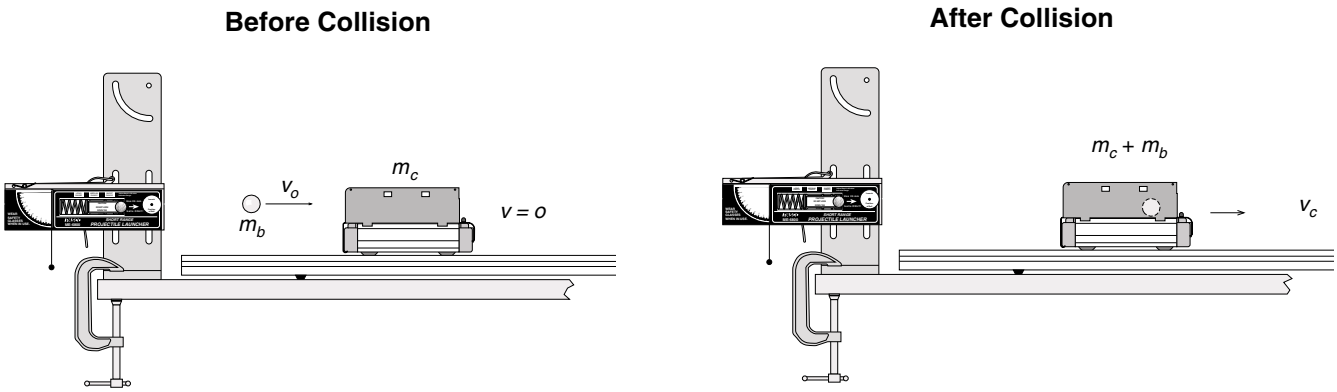


Figure 3.1: Conservation of Momentum in the Inelastic Collision

Momentum is conserved during the collision, but energy is not conserved. The momentum before the collision is equal to the momentum after the collision:

$$P_{before} = P_{after}$$
$$m_b v_o = (m_b + m_c) v_c$$

where m_b is the mass of the ball, v_o is the muzzle velocity of the ball, m_c is the mass of the catcher and cart, and v_c is the velocity of the cart and ball immediately after the collision. Solving for the final speed of the cart gives

$$v_c = \frac{m_b}{m_b + m_c} v_o$$

Elastic Collision

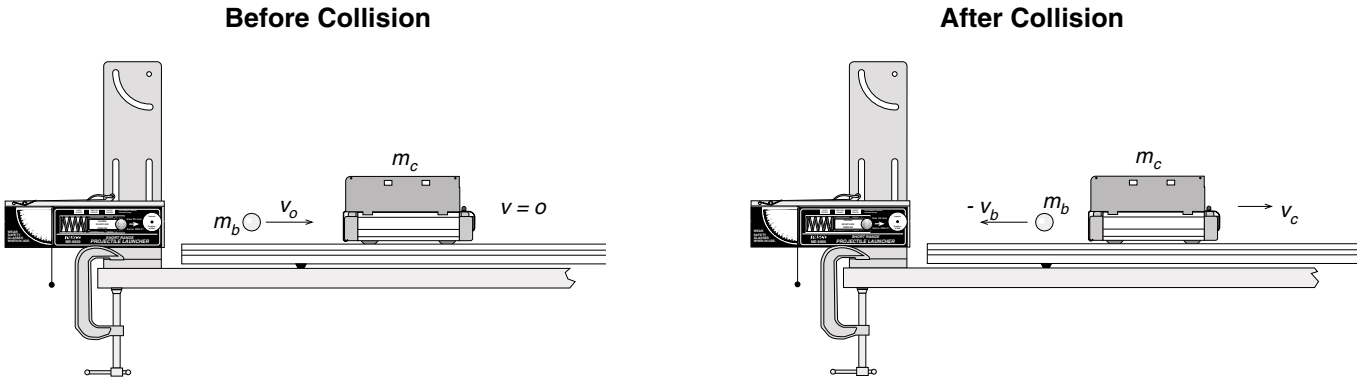


Figure 3.2: Conservation of Momentum in the Elastic Collision

The ball is launched horizontally and bounces off the catcher bumper on the cart. See Figure 3.2.

Momentum is conserved during the collision:

$$P_{before} = P_{after}$$

$$m_b v_0 = m_b v_b + m_c v_c$$

where m_b is the mass of the ball, v_o is the muzzle velocity of the ball, m_c is the mass of the catcher and cart, v_c is the speed of the cart immediately after the collision, and v_b is the speed of the ball immediately after the collision. In an elastic collision, kinetic energy is also conserved in the collision.

$$\frac{1}{2}m_b v_o^2 = \frac{1}{2}m_b v_b^2 + \frac{1}{2}m_c v_c^2$$

Solving the momentum equation for v_b gives

$$v_b = v_0 - \frac{m_c}{m_b}v_c$$

Solving for v_c gives

$$v_c = \frac{m_b}{m_b + m_c}v_0$$

which is twice the final cart speed found for the inelastic collision.

Setup

1. Clamp the Projectile Launcher to a sturdy table near one end of the table with the muzzle pointed toward the table.
2. Place the dynamics track on the table with one end against the base of the launcher. Align the track with the launcher by sighting through the launcher sites toward the far end of the track. See Figure 3.3. The track must be aligned with the launcher so that the ball pushes the cart straight down the track without derailing it.

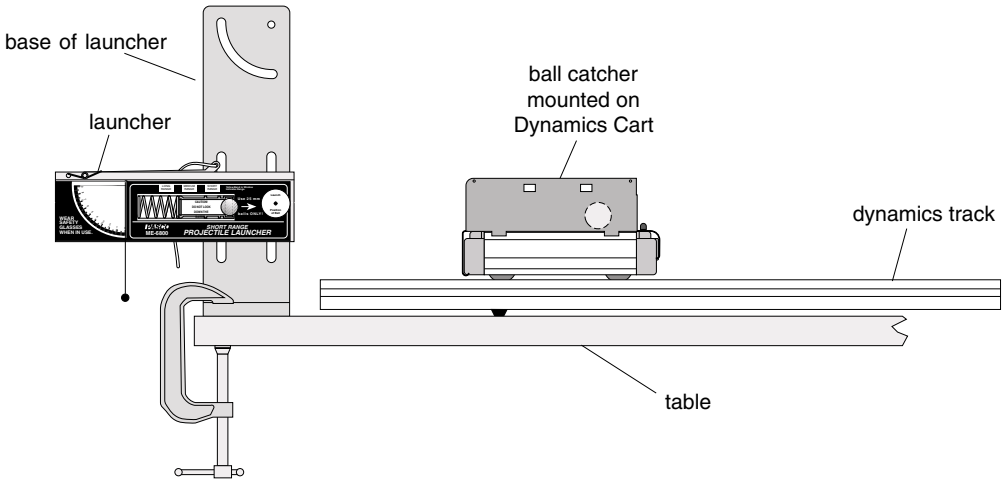


Figure 3.3: Experiment Setup

3. Mount the Projectile Launcher in the lower two slots on its base. Adjust the angle of the Projectile Launcher to zero degrees so that the ball will be shot off horizontally. Mount the catcher on the cart. Place the cart on the track at the end nearest the Launcher with the opening of the catcher facing the Launcher. Adjust the height of the Launcher so the ball will be shot into the center of the catcher.

Procedure

Inelastic Collision:

1. Put the ball into the Projectile Launcher, and cock it to the long range position. Put the cart on the track directly in front of the Launcher about 15 cm away from the muzzle.
2. Shoot the ball into the catcher and observe the resulting final speed of the cart.

Elastic Collision:

1. Lower the Launcher so the ball will hit the rubber bumper of the catcher on the cart.
2. Put the cart about 15 cm in front of the muzzle of the Launcher. This distance keeps the ball from rebounding into the Launcher.
3. Shoot the ball at the cart and observe the resulting speed of the cart.

➤ **NOTE:** Since there is no easy way to find the rebound speed of the ball in the elastic collision, this can only be a qualitative demonstration. Because the rubber bumper doesn't provide a perfectly elastic collision, the speed of the cart after the elastic collision will not be exactly twice the speed of the cart after the inelastic collision.

Teacher's Guide

Experiment 1: Ballistic Pendulum

Part I

Generally, determining the velocity of the ball by the "horizontal-shot" method is more accurate than using the photogate method, but the photogate method is quicker and easier.

If you use the photogate method, make sure that the photogates are parallel.

If you use the horizontal-shot method, make sure that the gun is perfectly horizontal. Use a spirit level for best results.

Part II

Setup: Ensure that the string is very loose in the Velcro assembly. There should be just enough friction so that that weight of the string does not pull the string through.

Procedure: It is helpful to anchor the string in place with a piece of tape (close to the velcro, on the opposite side from the pendulum) after firing but before measuring the height reached by the pendulum.

Notes on Analysis:

The difference between all measured velocities (by horizontal-shot, photogate, or ballistic pendulum measurement) should be less than 5%.

Answers to Questions:

1. The theoretical loss is:

$$\% \text{ lost} = \left[1 - \left(\frac{m_b}{m_b + m_p}\right)\right] \text{ x } 100\%$$

For our trials, the theoretical loss was 74.25%. The actual loss measured was 76.25%. The excess loss is most likely due to energy lost by rotational motion of the pendulum. (The motion of the pendulum is not entirely in the plane of the pendulum. There is some twisting, which requires energy.)

2. If the collision is perfectly elastic instead of perfectly inelastic, the height of the pendulum increases by a factor of $\sqrt{2}$. It is difficult to experimentally verify this because the collision is not perfectly elastic.

Experiment 2: Conservation of Momentum in an Inelastic Collision

Notes on Setup:

1. If you are using the 6500 and gate-pulse mode, position the Photogate so that it is blocked by the entire length of the catcher, rather than shining through the slots.

Notes on Procedure:

2. Make sure that the cart is far enough from the third photogate that the ball comes to rest relative to the cart before the cart begins to interrupt the photogate. (5 cm at least.)
3. The computer will give you more numbers than you need. Motion timer mode (with the 4-1 adapter) will give you four times.

For example:

0.0204 Time for the ball to go between the two Photogates (Use this to calculate ball velocity.)

0.1605 Time between when the ball interrupts the second Photogate and when the cart interrupts the third. (Ignore this number, it is meaningless.)

0.1186 Time between leading edge of first cart segment and leading edge of second cart segment. (Use this to calculate cart velocity.)

0.1198 Time between leading edge of second cart segment and leading edge of third cart segment. (Can also be used to calculate cart velocity.)

In Gate-Pulse mode, the computer will show five numbers. They are:

time 1 Duration of first Photogate's blockage by the ball

time 2 Time between unblocking first Photogate and blocking second

time 3 Duration of second Photogate's blockage by the ball

time 4 Time between unblocking second Photogate and blocking third with cart

time 5 Duration of third Photogate's blockage by the cart.

Add the first two times to find the total time it took the ball to travel the 10 cm between Photogates, and use this time to calculate the ball velocity. Ignore the third and fourth times given. Use the fifth time to calculate the cart velocity.

Analysis

2. If you are using the gate-pulse mode rather than motion timer, be sure to use the actual length of *whatever blocked the third Photogate the first time* to calculate cart velocity. In other words, if the photogate is aligned with the catcher slots, the length would be 4 cm; but if the photogate is not aligned with these slots, then use the entire length of the catcher.

4,8. The initial and final momentum should be within 10% of each other. They will not be exact because of inaccuracy in measuring velocity and because of frictional losses to the cart track.

5,6. The theoretical loss of kinetic energy is

$$\% \text{ lost} = \left[1 - \left(\frac{m_b}{m_b + m_p}\right)\right] \text{ x } 100\%$$

Actual loss will be slightly greater than this, due to friction between the cart and track.

Answers to Questions

1. Momentum is conserved, within the limits of measurement for this experiment.

2. Kinetic energy is not conserved.

Technical Support

Feed-Back

If you have any comments about this product or this manual, please let us know. If you have any suggestions on alternate experiments or find a problem in the manual, please tell us. PASCO appreciates any customer feed-back. Your input helps us evaluate and improve our product.

To Reach PASCO

For Technical Support, call us at 1-800-772-8700 (toll-free within the U.S.) or (916) 786-3800.

email: techsupp@PASCO.com

Tech support fax: (916) 786-3292

Web: http://www.pasco.com

Contacting Technical Support

Before you call the PASCO Technical Support staff, it would be helpful to prepare the following information:

- If your problem is computer/software related, note:

  Title and Revision Date of software

  Type of Computer (Make, Model, Speed)

  Type of external Cables/Peripherals

- If your problem is with the PASCO apparatus, note:

  Title and Model number (usually listed on the label)

  Approximate age of apparatus

  A detailed description of the problem/sequence of events. (In case you can't call PASCO right away, you won't lose valuable data.)

  If possible, have the apparatus within reach when calling. This makes descriptions of individual parts much easier.

- If your problem relates to the instruction manual, note:

  Part number and Revision (listed by month and year on the front cover)

  Have the manual at hand to discuss your questions.