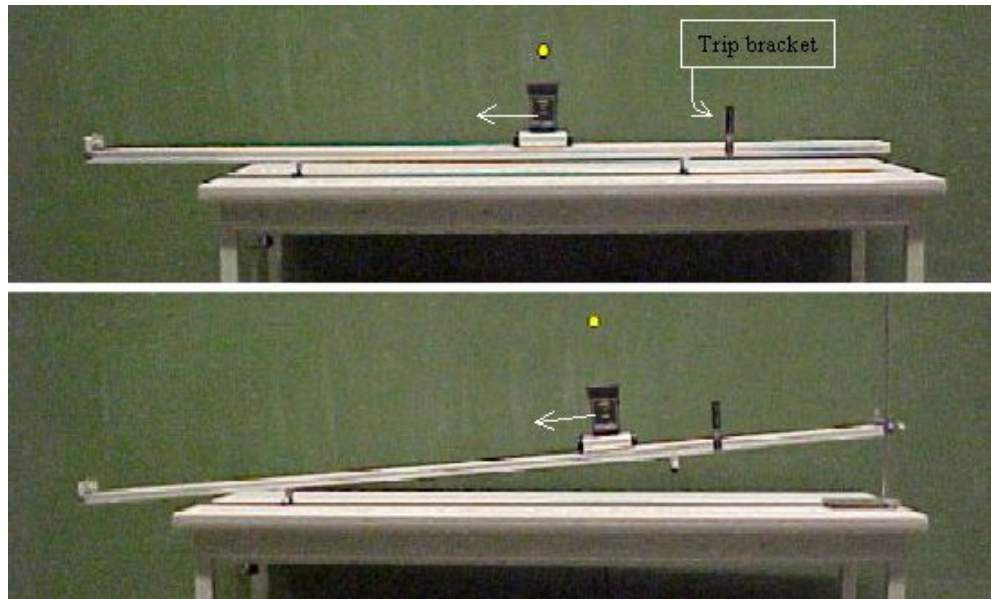


Shoot and catch

Aim: To show that when a ball is shot vertically upward from a cart moving at a constant speed, the ball will land back in the cart.

Subjects: 1E10 (Moving Reference Frames)

Diagram:



- Equipment:**
- Cart and track (we use PASCO-ME9452).
 - Ball-launch assembly (PASCO-ME9486).
 - Pulley at the end of the track.
 - Thread and weight (around 50 grams).

Shoot and catch

- Presentation:**
1. Set up the track horizontally. Mount the ball-launch assembly on the cart and install the bracket that can trip the photogate on the ball launcher near one end of the track (leave enough room to push the cart). Load the ball and make it launch while the cart stand still. The ball just moves upwards and is caught again by the launcher.
Then load the ball and start the cart by giving it a gentle push. The cart moves slowly, launches the ball on passing the trip bracket and further on the track the ball will be caught.
Return the cart to the end of the track. Reload the ball and give the cart a stronger push. The ball will be launched and caught.
 2. A pulley is clamped to the end of the track. Then a string is attached to the cart and passed over the pulley. Around 50 grams hangs on the string. Start the cart as far back as possible, load the ball ask the students what will happen and after their answers, let the cart go. The ball will fall behind the cart.
 3. Remove the wire with mass from the cart. Incline the track using table clamp and rod (see Diagram). Hold the cart at the top of the incline and load the ball. Ask the students: "Will the ball be caught after launching, yes or no". Release the cart. Also now, after launching the ball, it will land in the cart.
 4. Start the cart at the bottom of the incline. (If necessary reposition the trip bracket.) Again ask the same question to the students. Give the cart a push uphill so that it travels past the trip bracket. The ball is launched and caught again! It doesn't matter how fast the cart travels or where on the track the bracket launches the ball, all the time the launched ball is caught again.

- Explanation:**
1. The cart and ball have the same horizontal component of velocity. The horizontal component of acceleration of both cart and ball is zero, so ball and cart remain aligned (see Figure1).

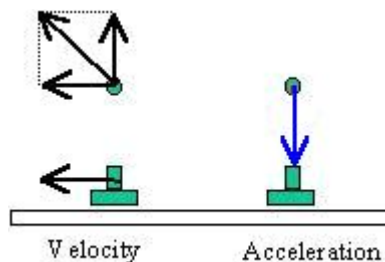


Figure 1

2. When the cart is accelerating, it is still accelerating after the ball has been launched. But after launching the ball is no longer accelerating in the horizontal direction, so it will lag behind the cart.
3. When the track is tilted, the cart and ball have the same component of acceleration parallel to the track (see Figure2). Since they have the same initial parallel-component velocity and the same parallel-component acceleration, they will thus always keep the same parallel-component velocity. The ball will always be in line with the cart perpendicular to the track, and it

Shoot and catch

will be caught.

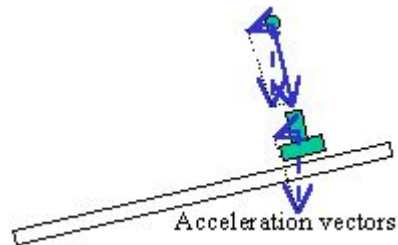


Figure 2

4. The same holds for the cart moving upward. So again see Figure2.

Remarks:

- Catch the cart before it reaches the end stop on the track.
- Presentation 1. can be made more attractive by placing a cardboard tunnel over the track.

Sources:

- [PASCO scientific, Instruction Manual and Experiment Guide](#)