PhyzLab: Going Through the Motions

an investigation of velocity and acceleration (REMEMBER: PENCIL)

☐			1
☐			2
☐			3
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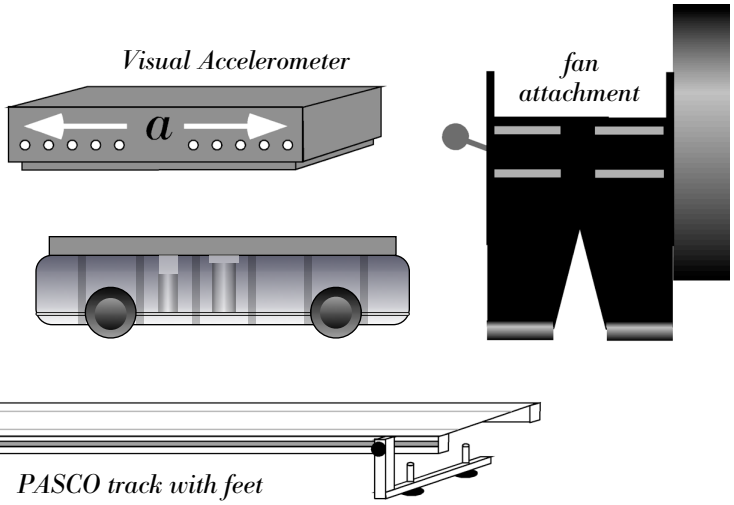
• Purpose •

This activity requires qualitative observations. You are to observe the two basic types of one-dimensional motion: uniform motion (constant speed) and uniform accelerated motion.

• Apparatus •

___ PASCO cart (GoCar or lightest available)
___ PASCO track
__adjustable leveling feet
___ PASCO Visual Accelerometer
___ PASCO fan attachment and batteries

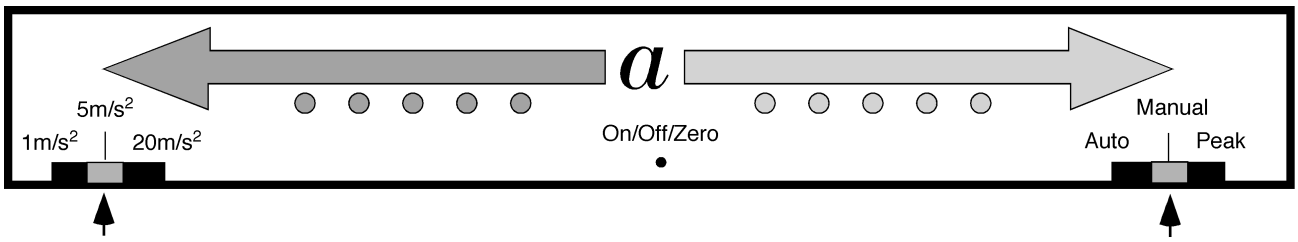


• Setup •

1. Arrange the track as shown above.
a. Attach the adjustable feet to both ends of the track.

b. Set the line level on the track and level the track by adjusting the feet. Fine-tune the level of the track by setting a dynamics cart on the track and pushing it lightly one way then the other. It should coast equally well in either direction. When not in use, keep the dynamics cart in its drawer or on its "back."

2. Prepare the Visual Accelerometer.
a. Attach the Visual Accelerometer to the cart. Use the two long, plastic screws and the threaded holes in the cart. Do not over-tighten since the plastic screws are easily stripped.



b. Set the range of the Visual Accelerometer to 5 m/s2. Set the mode of the VA to Manual.

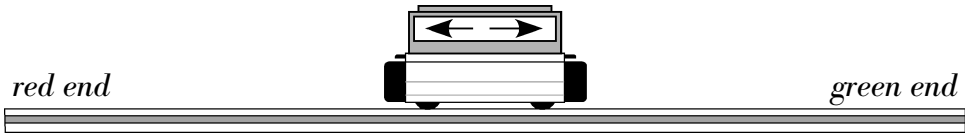
c. Park the VA on the level track. Activate the VA by quickly pressing and releasing the "On/Off/Zero" button between the red and green LEDs. The LEDs will flash and then go dark. **If any of the LEDs are ever on when the cart is at rest on the level track, quickly press and release the "On/Off/Zero"**

3. Set the fan attachment aside for now. You will use it later.

• Procedure •

1. LIGHT THE LEDS, OR NOT

a. Observation. Have two lab partners stand at opposite ends of the track. By the arrows on the Visual Accelerometer, one is at the "red" end and the other is at the "green" end. The red and green partners will take turns pushing and stopping the cart in a **gentle** game of catch. (The cart should move at about 1 m/s.)



Which LEDs light

i. when the red partner pushes the cart away?	__Red	__Green	__None
ii. as the cart coasts from the red partner to the green partner?	__Red	__Green	__None
iii. when the green partner catches the cart?	__Red	__Green	__None
iv. when the green partner pushes the cart away?	__Red	__Green	__None
v. as the cart coasts from the green partner to the red partner?	__Red	__Green	__None
vi. when the red partner catches the cart?	__Red	__Green	__None

b. Determination/Observation. What motion(s) of the cart will make the green LEDs light up?

[Note: There are **two** different motions that will produce the desired result; describe each. Describe the **direction** of motion and whether the cart is **speeding up, slowing down,** or **maintaining constant speed.** Do not use the term "acceleration" in your descriptions here. To simplify this first trial, check the appropriate descriptions below.]

First Successful Motion:

The cart is moving in the __red / __green (choose one) direction while __speeding up / __slowing down / __at constant speed (choose one).

Second Successful Motion (structure your response to match the completed statement above):

c. Determination/Observation. What **two** motions of the cart will make the **red** LEDs light up?

d. Determination/Observation. Under what conditions will none of the LEDs light?

2. ONE LIGHT TWO LIGHTS RED LIGHTS GREEN LIGHTS

a. Consider each type of motion indicated below. Velocity and acceleration vectors (arrows) have been drawn. Shade in the arrow over the illuminated LEDs in each case. If no LEDs remain lit throughout the motion, do not shade either arrow. **Above each cart pictured below, indicate whether the motion is uniform motion (UM) or accelerated motion (AM).**

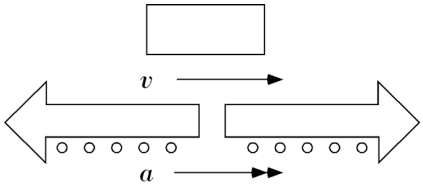


Figure 1. Cart is traveling greenward and quickly speeding up.

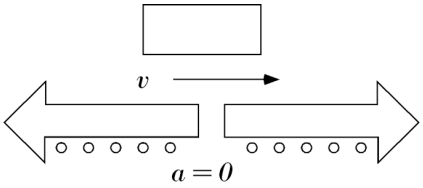


Figure 2. Cart is traveling greenward and maintaining constant speed.

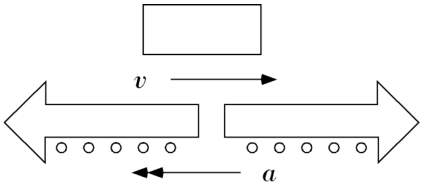


Figure 3. Cart is traveling greenward and quickly slowing down.

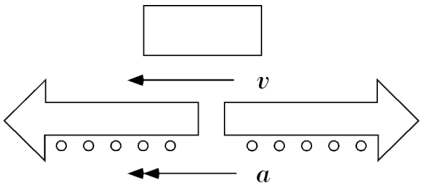


Figure 4. Cart is traveling redward and quickly speeding up.

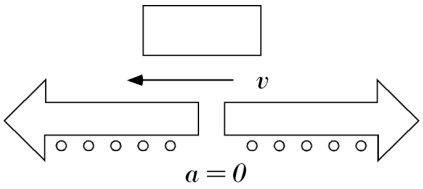


Figure 5. Cart is traveling redward and maintaining constant speed.

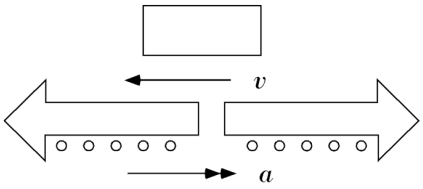


Figure 6. Cart is traveling redward and quickly slowing down.

b. Analysis. Look at the location of the illuminated LEDs and the velocity and acceleration vectors (arrows). What do the LEDs tell you about the motion of the cart? You can use any of these terms (and variations) to answer the questions that follow.

- "velocity"
- "speed"
- "acceleration"
- "light up"
- "remain unlit"

c. Fill in the blank. The illuminated LEDs always indicate the direction of the cart's _____

d. If the cart is not accelerating, the LEDs _____. If any LEDs are

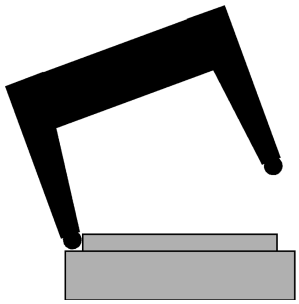
illuminated, the cart is _____.

3. YOUR BIGGEST FAN

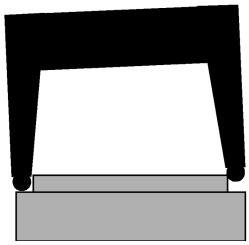
a. Check to see that the fan attachment has four batteries in the battery compartment (in the "belly" of the motor section). Turn the fan on and off (quickly) to verify that it works.

b. Set the range of the Visual Accelerometer to **1 m/s²**. (Recall that it had been set to 5 m/s² previously.)

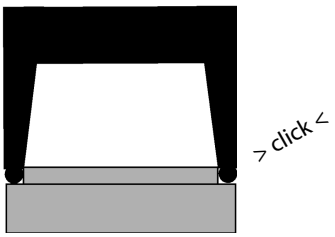
c. Attach the fan to the Visual Accelerometer. The cylindrical "feet" of the fan attachment are designed to grip the top "rails" of the Visual Accelerometer.



i. Set the fan attachment so one side is in place on one side of the accelerometer.



ii. Lower the other side until it's in contact with the other side of the accelerometer.



iii. Carefully but firmly press to fit.

d. Allow the cart to roll from one end of the track to the other propelled only by the thrust of the fan. Stop the cart with your hands to prevent a crash at the end. Describe the motion and the LED illumination (if any).

e. With the cart now at the end of the track that the fan propelled it to, prepare to give the cart an abrupt impulse "backward" (against the thrust of the fan). Give the cart the impulse then let it roll freely. The cart should move at least 50 centimeters away from you then come back to you. The cart should not collide with the far end of the track.

i. Describe the motion and the LED illumination (if any).

ii. Consider the motion of the cart **after** you pushed it and **before** you caught it.

· Is there any point at which all LEDs are out (off)? What does that mean about the motion during this time?

· Is there any point at which the cart comes to rest (even if only for an instant)? If so, where; if not, why not?

f. Experiment to recreate the motions (and LED patterns) demonstrated in step 2.a., figures 1, 3, 4, and 6. The fan must be on and the cart must be rolling freely in each recreation, but you are free to aim the fan greenward **or** redward, and you are free to start the cart with a **non-zero initial speed**.

Describe and illustrate how you recreated the motion in

i. Figure 1. Cart is traveling greenward and quickly speeding up.

ii. Figure 3. Cart is traveling greenward and quickly slowing down.

iii. Figure 4. Cart is traveling redward and quickly speeding up.

iv. Figure 6. Cart is traveling redward and quickly slowing down.

e. Now create motions to match the following figures. Give a **full description** for each arrangement.

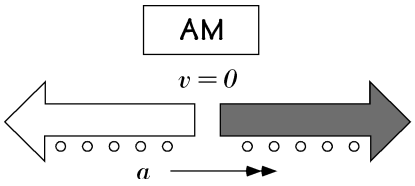


Figure 7. Cart is at rest and accelerating in the green direction.

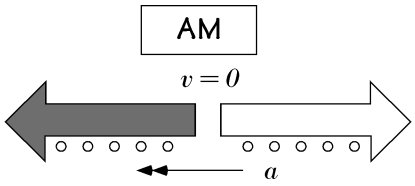


Figure 8. Cart is at rest and accelerating in the red direction.

• Analysis •

1. Write a "√" mark next to each description of motion that is physically possible. Draw an "X" next to each description of motion that is physically impossible. If the motion is possible, identify all figures (1–8) from procedures 2 and 3 of the activity that correspond to the motion.

___ a. Velocity and acceleration in the same direction. If possible, in which figure/s is this shown? _____

___ b. Velocity and acceleration in opposite directions. If possible, in which figure/s is this shown? _____

___ c. Velocity with no acceleration ($v \neq 0$ while $a = 0$). If possible, in which figure/s is this shown? _____

___ d. Acceleration with no velocity ($a \neq 0$ while $v = 0$). If possible, in which figure/s is this shown? _____

___ e. No velocity and no acceleration ($v = 0$ while $a = 0$).

2. a. When the cart is speeding up, its velocity and acceleration
__ are in the same direction (parallel).
__ are in opposite directions (antiparallel).
__ could be parallel or antiparallel.

b. When the cart is slowing down, its velocity and acceleration
__ are in the same direction (parallel).
__ are in opposite directions (antiparallel).
__ could be parallel or antiparallel.