PhyzLab: Going Through the Motions

an investigation of velocity and acceleration (REMEMBER: PENCIL)

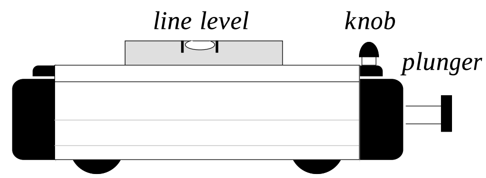
• Purpose •

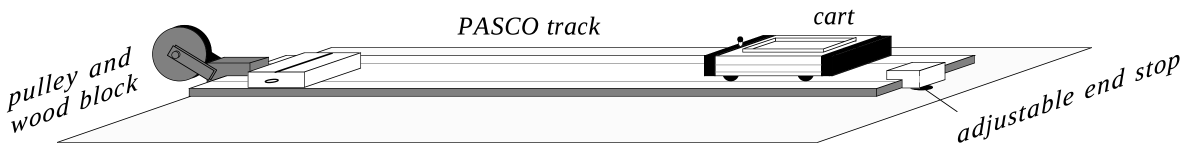
This activity requires qualitative observations. You are to observe the two basic types of one-dimensional motion: uniform motion (constant speed) and uniform accelerated motion.

• Apparatus •

___ PASCO dynamics cart with plunger
___ PASCO aluminum track
___ line level (glass tube with yellow/green liquid and a bubble)
___ pulley clamp
___ wood block
___ 2 hex nuts (or equivalent)
___ string

The PASCO Dynamics Cart: Top of the line: precision, low-friction bearings, three-setting plunger, retractable wheels, magnetic bumpers, velcro bumpers; in a word: **expensive!**





• Set-Up •

1. Arrange the apparatus as shown above. Attach the pulley clamp securely to the track—thumbscrew side down—so the the pulley wheel itself hangs over one edge of the table. and don't forget the wood block.

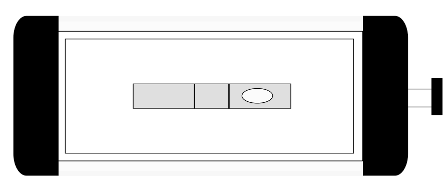
2. Set the line level on the track and level the track by adjusting the foot on the adjustable end stop. Extend or retract the foot by turning it clockwise or counterclockwise. When the track is level, the cart should coast equally well at low speeds going either way. (If you cannot get the track level, try reversing its direction on your table.)

3. Set the line level in the bed of the cart. Keep the plunger side of the cart toward the pulley.

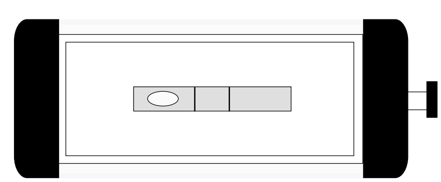
• Procedure •

1. MOVE THE BUBBLE, OR NOT

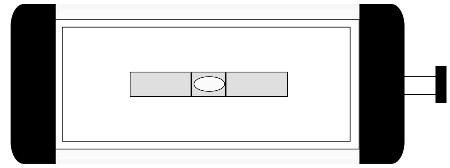
a. Determination/Observation. What motion(s) of the cart will make the bubble move to the plunger side of the cart? Move the cart with your hand; try different types of motion. In your description of the motion(s) that meet the criterion, be sure to identify the motion(s) as uniform motion (UM) or uniform accelerated motion (UAM).



b. Determination/Observation. What motion(s) of the cart will make the bubble move to the side of the cart opposite the plunger? Move the cart with your hand; try different types of motion. In your description of the motion(s) that meet the criterion, be sure to identify the motion(s) as UM or UAM.



c. Determination/Observation. What motion(s) of the cart will make the bubble stay in the center or return to the center of the level and remain there? Move the cart with your hand; try different types of motion. In your description of the motion(s) that meet the criterion, be sure to identify the motion(s) as UM or UAM.



2. WHERE'S THE BUBBLE?

a. Consider each type of motion indicated below. Velocity and acceleration vectors (arrows) have been drawn. Draw the location of the bubble in the line level for each case. Above each cart pictured below, indicate whether the motion is UM or UAM.

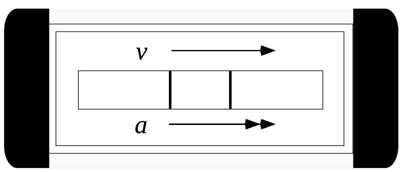


Figure 1. Cart is traveling to the right and quickly speeding up.

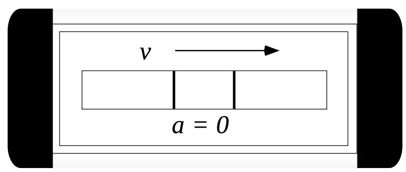


Figure 2. Cart is traveling to the right and maintaining constant speed.

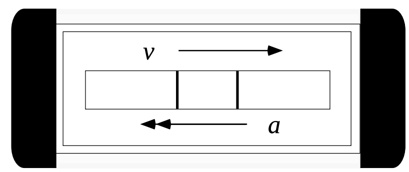


Figure 3. Cart is traveling to the right and quickly slowing down.

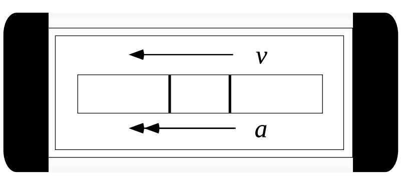


Figure 4. Cart is traveling to the left and quickly speeding up.

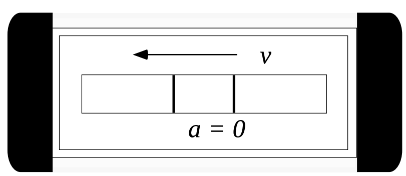


Figure 5. Cart is traveling to the left and maintaining constant speed.

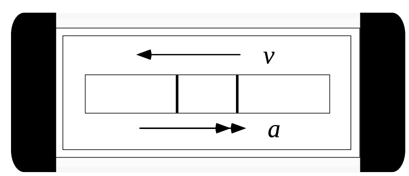


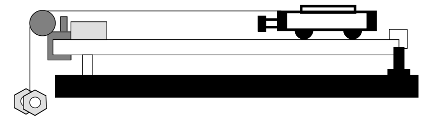
Figure 6. Cart is traveling to the left and quickly slowing down.

b. Analysis. Look at the location of the bubble and the velocity and acceleration vectors (arrows). What does the location of the bubble tell you about the motion of the cart?

c. Fill in the blank. The direction the bubble moves is always the same as the direction of the cart's ________________

d. If the cart is not accelerating, the bubble is ______________________________________. If the bubble is not in the middle of the tube, the cart is ______________________________________.

3. PULLING MOTION (IT IS CRITICAL THAT THE TRACK IS LEVEL!)



a. Set-Up. **Follow these instructions carefully!**

i. Obtain a length of string. Attach it to the small knob atop the cart. Use a simple slip knot so you can remove the string easily later.

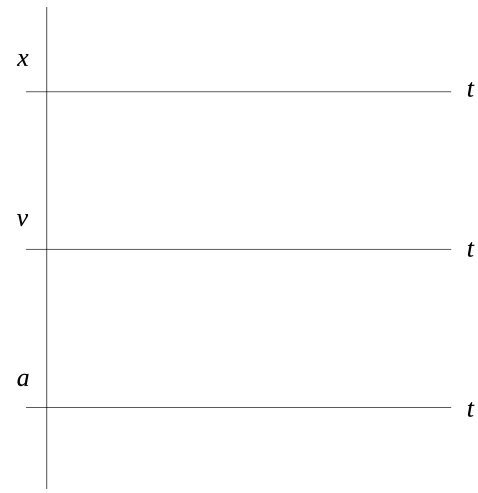
ii. Pass the string over the pulley.

iii. Obtain two hex nuts. Attach them to the free end of the string. The string should be of a length such that hex nuts hit the floor when the cart hits the bumper block. This need not be exact, but should serve as a goal. It is better if the string is a bit too short and does not allow the nut to hit the ground than if the string is too long.

iv. The hex nuts must be able to fall downward to the floor without obstruction; the pulley wheel must turn freely.

b. Observation. Pull the cart back until the hex nut is just below the pulley wheel. Let go of the cart and observe the motion (and bubble). **The motion ends just *before* the cart hits the bumper block.**

i. Describe the motion in words.



ii. Draw the kinematics graphs of the motion. Begin with the velocity graph. (Did the velocity start positive, negative, or at zero? Did it then increase, decrease, or remain constant?) Consult your *PhyzExample* pages for clues on how to graph position and acceleration vs. clock reading for this motion.

c. Observation. Rest the cart against the bumper block. Give the cart an abrupt impulse away from the bumper block. Observe the subsequent motion (and bubble location). **The motion ends just *before* the cart hits the bumper block.**

i. Complete the diagrams below by **drawing velocity and acceleration vectors** (and bubble location) as was done in part 2.a. above.

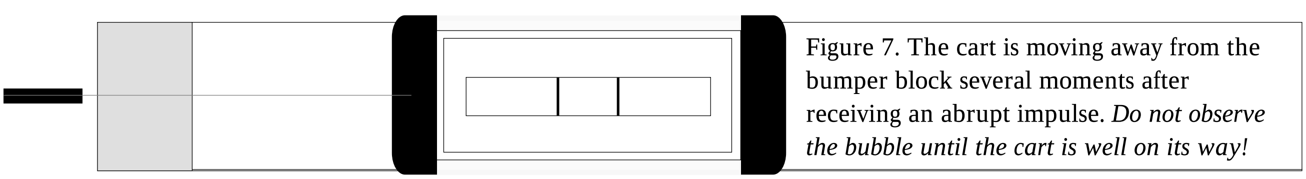


Figure 7. The cart is moving away from the bumper block several moments after receiving an abrupt impulse. *Do not observe the bubble until the cart is well on its way!*

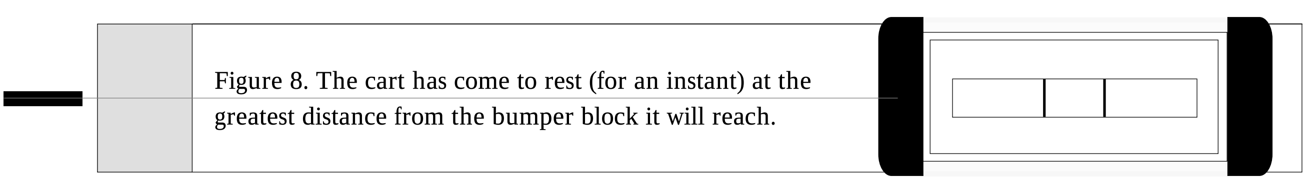


Figure 8. The cart has come to rest (for an instant) at the greatest distance from the bumper block it will reach.

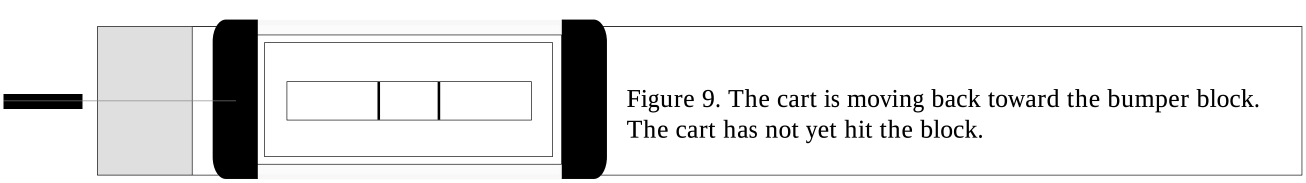
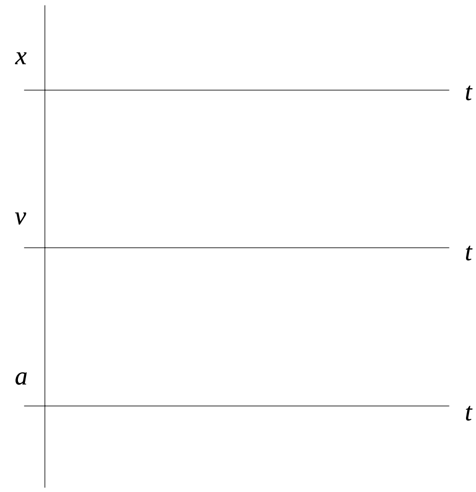


Figure 9. The cart is moving back toward the bumper block. The cart has not yet hit the block.

ii. Draw the kinematics graphs of the motion. The motion begins (t=0) *shortly after* the cart has been given the abrupt impulse away from the bumper block. **The motion ends *just before* the cart hits the bumper block on its way back.**



Consider the positive direction to be **away** from the pulley and block. Thus, the initial velocity is positive.

iii. What happens to the position of the cart during the run?

iv. In what direction is the cart moving before it comes to that instant of rest? (Positive or negative.)

v. In what direction is the cart moving after it comes to that instant of rest? Is this change of direction reflected in your velocity graph or do you show the cart moving in only one direction?

vi. Describe the acceleration of the cart in figure 7 above. (If there is acceleration, is it positive or negative?)

vii. Describe the acceleration of the cart in figure 8 above. (If there is acceleration, is it positive or negative?)

viii. Describe the acceleration of the cart in figure 9 above. (If there is acceleration, is it positive or negative?)

ix. Recall your finding from part 2.b. above. Are the answers to the previous three questions and your acceleration graph consistent with your observation in part 3.c.i. and this finding?

• Analysis •

Draw a "√" mark next to each description of motion that can occur. Draw an "X" next to each description of motion that cannot occur. If the motion is possible, identify a figure (1-9) from the lab that depicts that motion or write "none" if the motion is not depicted in any of the figures.

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

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

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

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

___ No velocity and no acceleration ($v=0$ while $a=0$). If possible, in which figure—if any—is this shown? _____