

### I. Velocity and Acceleration

You will be instructed as to how the sonic rangers work for this lab. Let motion *away from* the sonic ranger be **positive**, while any motion *towards* the ranger will be **negative**.

Set the LoggerPro program to take data for 50 seconds, at 20 samples per second.

A. Start the ranger taking data. Have one group member walk at a constant speed away from the ranger, stop for a few seconds, then walk back towards the ranger. For all **three** instants below,

- (1) [2 pts] list the numerical value for the velocity (**include +/- signs**) you read on the ranger, and
- (2) [2 pts] draw a vector that represents the magnitude **and** direction of the velocity.

$v_1 =$  \_\_\_\_\_

$v_3 =$  \_\_\_\_\_

$v_2 =$  \_\_\_\_\_



B. Have someone else sit in a lab chair in front of the ranger. Have them push away from the ranger so they come to a stop near the far wall. Consider two points while the student was speeding up, and two points while the student was slowing down. For all **4** instants on the diagram below,

- [4 pts] list the numerical value for the velocity (include +/- signs) you read on the ranger, and
- [4 pts] draw a vector that represents the magnitude and direction of the velocity.



[6 pts] Use the numbers while the student was **speeding up** to calculate the acceleration  $\vec{a} = \Delta\vec{v} / \Delta\vec{t} = (\vec{v}_f - \vec{v}_i) / (t_f - t_i)$ . Show your work below (include units **and** signs).

$v_1 =$  \_\_\_\_\_       $t_1 =$  \_\_\_\_\_

$v_2 =$  \_\_\_\_\_       $t_2 =$  \_\_\_\_\_

[6 pts] Use the numbers while the student was **slowing down** to calculate the acceleration  $\vec{a} = \Delta\vec{v} / \Delta\vec{t} = (\vec{v}_f - \vec{v}_i) / (t_f - t_i)$ . Show your work below (include units **and** signs).

$v_3 =$  \_\_\_\_\_       $t_3 =$  \_\_\_\_\_

$v_4 =$  \_\_\_\_\_       $t_4 =$  \_\_\_\_\_

[4 pts] Select the segment on the velocity graph between the two points you picked for **slowing down**. Go to the “Analyze” menu and choose “linear fit” to get the slope; this slope is the acceleration. Write that number in the space to the right (with units and +/- sign!).

a= \_\_\_\_\_

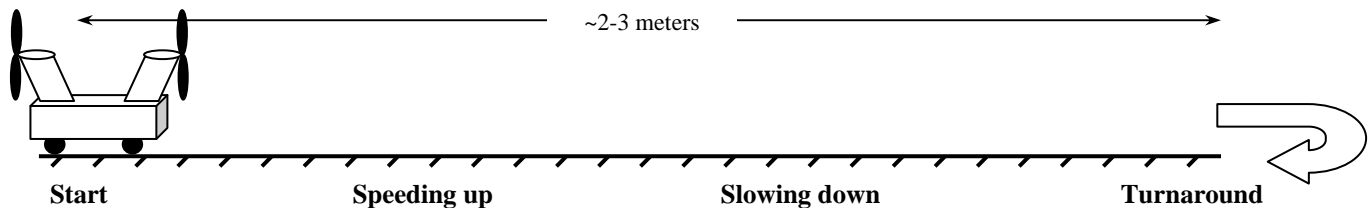
[2 pts] How does this number compare to the acceleration **you** calculated on the previous page using  $\Delta\vec{v} / \Delta\vec{t}$  ? (Circle one answer.)

About the same

Very different

**II. Velocity and Acceleration—fan cart physics**

The drawing below shows a fan cart moving along the floor. Use one engine to send it away from you, and then use the other engine to turn it around and bring it back to you. Point the sonic ranger at the fan cart.



[4 pts] Use the numbers while the fancart was **speeding up** to calculate the acceleration  $\vec{a} = \Delta\vec{v} / \Delta\vec{t} = (\vec{v}_f - \vec{v}_i) / (t_f - t_i)$ . Show your work below (include units **and** signs).

[4 pts] Use the numbers while the fancart was **slowing down** to calculate the acceleration  $\vec{a} = \Delta\vec{v} / \Delta\vec{t} = (\vec{v}_f - \vec{v}_i) / (t_f - t_i)$ . Show your work below (include units **and** signs).

[6 pts] Consider the turnaround point. Use your computer graphs to determine the velocity of the cart at the following three instants (include + or – signs and units):

(1) a short time before the turnaround (maybe ¼ second): v=\_\_\_\_\_ t=\_\_\_\_\_

(2) exactly at the turnaround point: v=\_\_\_\_\_ t=\_\_\_\_\_

(3) a short time after the turnaround (maybe ¼ second): v=\_\_\_\_\_ t=\_\_\_\_\_

[6 pts] Use the equation  $\vec{a} = \Delta\vec{v} / \Delta\vec{t} = (\vec{v}_f - \vec{v}_i) / (t_f - t_i)$  to calculate the acceleration between points (1) and (2), points (2) and (3), and points (1) and (3). Be careful with the times  $\Delta\vec{t}$ .

$\vec{a}_{(1)\rightarrow(2)} =$

$\vec{a}_{(2)\rightarrow(3)} =$

$\vec{a}_{(1)\rightarrow(3)} =$

[4 pts] Were these numbers (circle one)      about the same?      very different?

[4 pts] Select the segment of the velocity graph from a short time before to a short time after the turnaround point. Go to the “Analyze” menu and choose “linear fit” to get the slope; this slope is the acceleration. Write that number below with the correct units and sign.

[2 pts] How does the number above compare to the acceleration on the previous page using  $\Delta\vec{v}/\Delta\vec{t}$  ?

Answer the following questions about the turnaround point (Hint: Use your numbers from this lab to help with this.):

1. [2 pts] While the fan cart is speeding up, describe how the direction of the acceleration compares to that of the velocity (i.e., the same, opposite, etc.):
2. [2 pts] While the fan cart is slowing, describe how the direction of the acceleration compares to that of the velocity (i.e., the same, opposite, etc.):
3. [2 pts] When the fan cart is *exactly* at the turnaround point, is the *velocity* zero or non-zero?
4. [2 pts] When the fan cart is *exactly* at the turnaround point, is the *acceleration* zero or non-zero?
5. [2 pts] One of your friends makes the statement that, “I think that *both* the velocity and the acceleration are zero exactly at the turnaround point.” In the space below, discuss what would happen if the acceleration of the fan cart *actually was zero* at the turnaround point.

*Have these answers checked—and discuss them with a staff member—before turning these sheets in for a grade.*