

## Translating Graphs of Velocity vs. Time

### Purpose and Expected Outcome

After doing this activity, you should be able to associate the motion of objects with graphs of velocity vs. time.

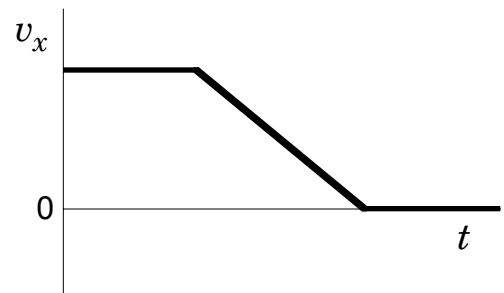
### Prior Experience / Knowledge Needed

You should be familiar with velocity vs. time plots and recognize that they are different than position vs. time plots.

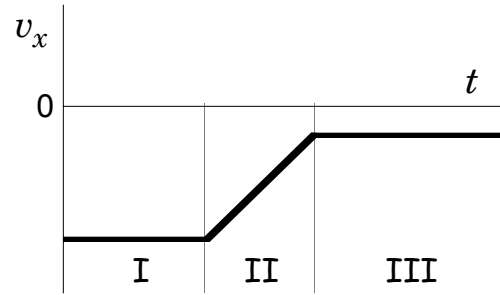
### Explanation of Activity

(a) Using common classroom items (e.g., rubber or steel balls, springs, ramps, and carts), make some object move in a manner that is qualitatively in agreement with the following graphs. (b) Write an explanation of how you accomplished this, noting the location of your origin and the orientation of your  $x$ -axis. (c) Label the critical points and time intervals of the graphs.

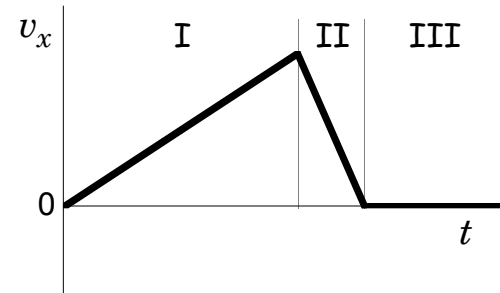
- A1.** (a) What object did you choose to make move like this graph?  
(b) Describe how you did it.  
(c) On a copy of this graph, label the critical time periods. In particular, what is happening while the graph is horizontal at the beginning? at the end? What is happening while the graph is at an angle?



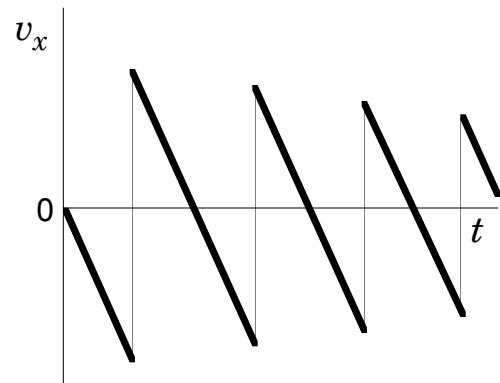
- A2.** (a) What object did you use for this graph?  
 (b) How did you do it?  
 (c) Describe what is happening during time periods I, II, and III.



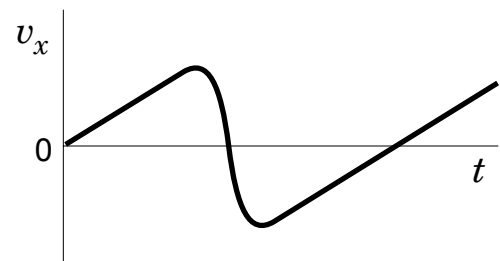
- A3.** (a) What object did you use for this graph?  
 (b) How did you do it?  
 (c) Describe what is happening during time periods I, II, and III.



- A4.** (a) What object did you use for this graph?  
 (b) How did you do it?  
 (c) Make a sketch of this graph and label it.



- A5.** (a) What object did you use for this graph?  
 (b) How did you do it?  
 (c) Label a copy of this graph. In particular, indicate the times at which the object is at rest.



## Integration of Ideas

Consider the graph of velocity vs. time at the right, and use this graph to answer the following questions:

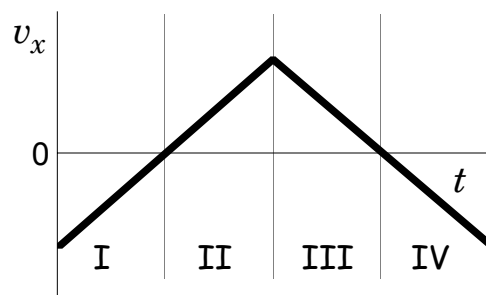
**I1.** During which time intervals (I, II, III, or IV) is the speed of the object decreasing?

**I2.** During which time intervals is the speed increasing?

**I3.** During which time intervals is the object moving in the positive direction?

**I4.** During which time intervals is the object moving in the negative direction?

**I5.** During which time intervals is  $v_x$  increasing?



**I6.** Make a table indicating the sign of the slope of  $v_x$  vs.  $t$  in each of the situations described below. (Use + to indicate a positive slope, 0 to indicate a zero slope, and – to indicate a negative slope. Some answers have been provided.)

How the speed is changing	Sign of slope when direction of motion is positive.	Sign of slope when direction of motion is negative.
Speed is increasing. (Object is speeding up.)	+	
Speed is not changing. (Speed is constant.)		0
Speed is decreasing. (Object is slowing down.)		

**I7.** Can the slope of velocity vs. time be negative even though the object is speeding up? Explain. Give an example.

**I8.** Can the slope of velocity vs. time be positive even though the object is slowing down? Explain. Give at least one example.

## Reflection

- R1.** Consider questions I2 and I5 of the Integration of Ideas. Are the time intervals during which the speed is increasing the same as the time intervals during which  $v_x$  is increasing? Explain.
- R2.** (a) If an object is slowing down, in what direction does its change in velocity point? Explain.  
(b) If an object is speeding up, in what direction does its change in velocity point? Explain.
- R3.** (a) If the slope of velocity vs. time is positive, is the change in velocity positive or negative? Explain.  
(b) If the slope of velocity vs. time is negative, is the change in velocity positive or negative? Explain.
- R4.** Can the slope of velocity vs. time always help you determine if something is slowing down or speeding up? What additional information do you need to determine if it is slowing down or not?