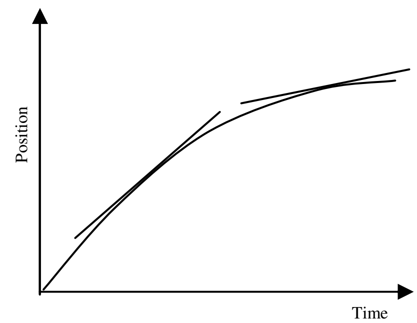
SPH3U: Speeding Up or Slowing Down?

Recorder: ___________________
Manager: ___________________
Speaker: ___________________
0 1 2 3 4 5

There is one mystery concerning acceleration remaining to be solved. Our definition of acceleration, $\Delta v/\Delta t$, allows the result to be either positive or negative, but what does that mean? Today we will get to the bottom of this.

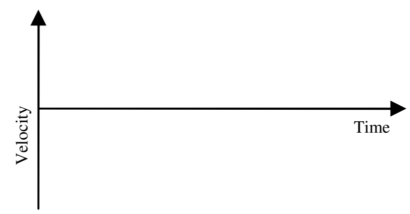
A: Acceleration in Graphs

Your teacher has set-up a cart with a fan on a dynamics track and a motion detector to help create position-time and velocity-time graphs. Let's begin with a position graph before we observe the motion. The cart is initially moving forward. The fan is on and gives the cart a steady, gentle push which causes the cart to accelerate.



1. **Interpret.** What does the slope of a tangent to a position-time graph represent?

2. **Reason.** Is the cart speeding up or slowing down? Use the two tangents to the graph to help explain.



3. **Reason.** Is the change in velocity positive or negative? What does this tell us about the acceleration?

Description:

4. **Predict.** What will the velocity-time graph look like? Use a dashed line to sketch this graph on the axes above.

5. **Test.** (*as a class*) Observe the velocity-time graph produced by the computer for this situation. Describe the motion. Explain any differences between your prediction and your observations.

B: The Sign of the Acceleration

All the questions here refer to the chart on the next page.

1. **Represent.** In the chart, draw an arrow corresponding to the direction the fan pushes on the cart. Label this arrow "F" for the force.

2. **Predict.** (*work individually*) For each situation (each column), use a dashed line to sketch your prediction for the position- and velocity-time graphs that will be produced. Complete the graphs for each example on our own and then compare your predictions with your group. Note: It may be easiest to start with the *v-t* graph and you can try the acceleration-time graph if you like.

3. **Test.** (*as a class*) Observe the results from the computer. Use a solid line to draw the results for the three graphs in the chart on the next page.

4. **Interpret.** Examine the velocity graphs. Is the magnitude of the velocity (the speed) getting larger or smaller? Decide whether the cart is speeding up or slowing down.

5. **Interpret.** Use the graphs to decide on the sign of the velocity and the acceleration.

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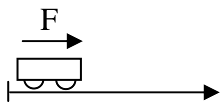
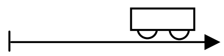
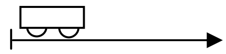
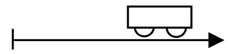
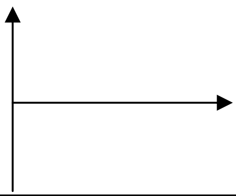
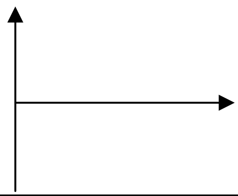
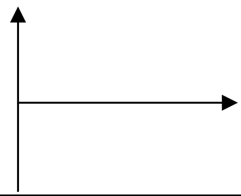
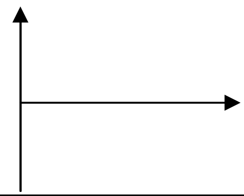
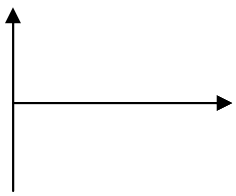
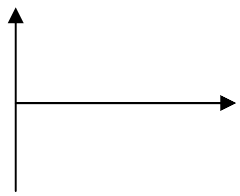
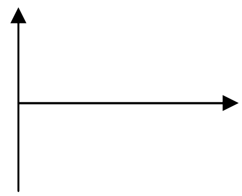
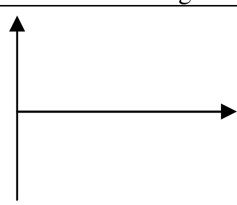
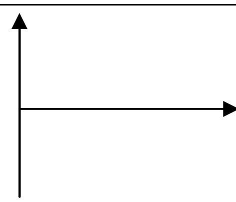
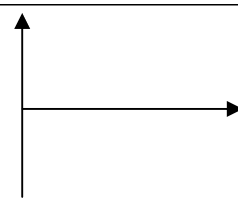
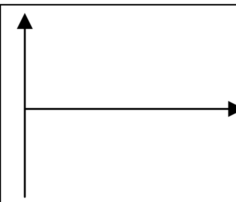
	1	2	3	4
Description	The cart is released from rest near the motion detector. The fan pushes on the cart **away** from the detector.	The cart is released from rest far from the detector. The fan pushes **towards** the detector.	The cart is moving away from the detector. The fan pushes **towards** the detector.	The cart is moving towards the detector. The fan is pushing **away** from the detector.
Sketch with Force				
Position graph				
Velocity graph				

We will continue the rest of the chart together after our observations.

Acceleration graph				
Slowing down or speeding up?				
Sign of Velocity				
Sign of Acceleration				

Now let's try to interpret the sign of the acceleration carefully. Acceleration is a **vector** quantity, so the sign indicates a direction. This is **not** the direction of the object's motion! To understand what it is the direction of, we must do some careful thinking.

6. **Reason.** Emmy says, "We can see from these results that when the acceleration is positive, the object always speeds up." Do you agree with Emmy? Explain.

7. **Reason.** What conditions for the acceleration and velocity must be true for an object to be speeding up? To be slowing down?

8. **Reason.** Which quantity in our chart above does the sign of the acceleration **always** match?

Always compare the magnitudes of the velocities, the speeds, using the terms *faster* or *slower*. Describe the motion of accelerating objects as *speeding up* or *slowing down* and state whether it is moving in the positive of negative direction. Other ways of describing velocity often lead to ambiguity and trouble! **Never** use the d-word, *deceleration* - yikes! Note that we will always assume the acceleration is uniform (constant) unless there is a good reason to believe otherwise.