SPH3U: Speeding Up or Slowing Down?

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

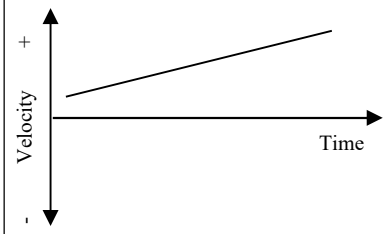
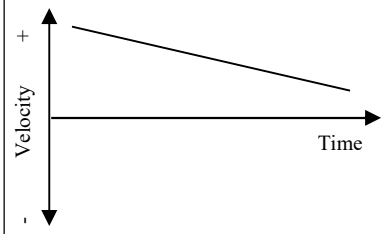
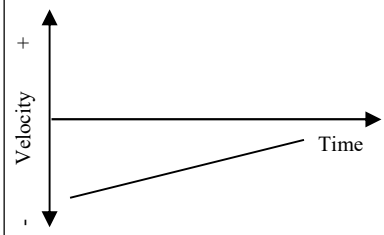
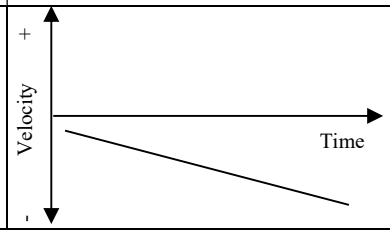
There is one mystery concerning acceleration remaining to be solved. Our definition of acceleration, $\Delta v/\Delta t$, allows the result to be either positive or negative, but what does that mean? Today we will get to the bottom of this.

Part A: The Sign of the Acceleration

Consider this situation: A bicycle accelerates uniformly from a velocity of -3.0 m/s to a velocity of -7.0 m/s. Note that it is always moving in the negative direction, or west, for example. This change in velocity takes 10 s.

1. Without making the acceleration calculation, explain what the sign of the bicycle's acceleration will be.

2. (*work individually)* The sign of the acceleration is not easy to interpret. Consider the four velocity-time graphs below. For each graph indicate: the sign of the velocity, whether its magnitude (speed) is getting larger or smaller, the sign of the acceleration, whether the object is speeding up or slowing down. *Try each row individually and then compare your results with your group members*.

	Graph	Sign of Velocity	Magnitude of Velocity	Sign of Acceleration	SU or SD?
1					
2					
3					
4					

3. Which graph corresponds to the bicycle example we started with? Explain.

4. Which quantity from the chart tells us the *direction of motion* of the object? Explain.

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 more work.

5. Can we convincingly state that if the acceleration is positive the object is speeding up? What about a negative acceleration and slowing down?

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

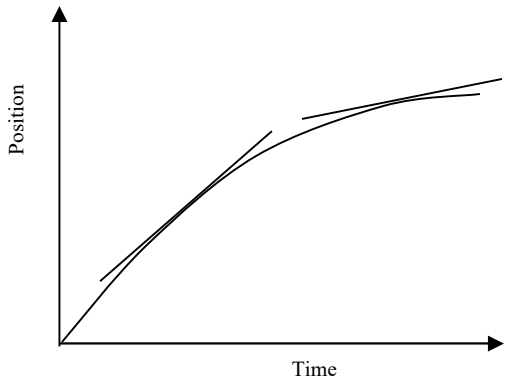
Always compare the magnitudes of the velocities, the speeds, using the terms *faster* or *slower*. Describe the motion of accelerating objects as *speeding up* or *slowing down* and state whether it is moving in the positive of negative direction. Other ways of describing velocity often lead to ambiguity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

Part B: Speeding Up and Slowing Down on Position-Time Graphs

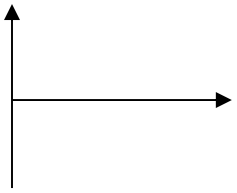
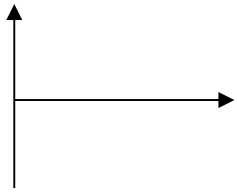
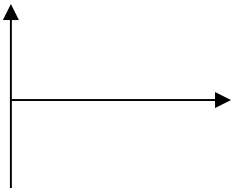
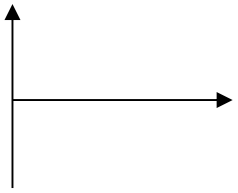
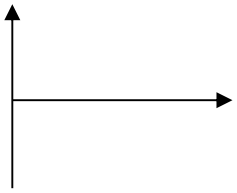
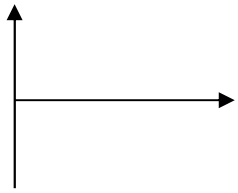
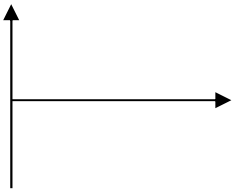
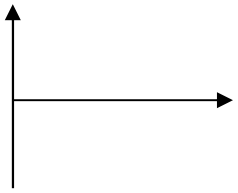
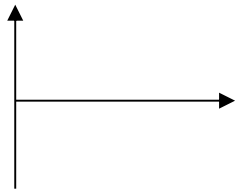
Our final step in understanding this business of speeding up and slowing down is their representation in a position-time graph. Consider the position-time graph shown below which represents the motion of a cart on an inclined ramp. The incline gives a steady, gentle pull which changes the velocity of the cart.

1. Use the two tangents to the graph to help you to explain whether the cart is speeding up or slowing down in this example.

2. What are the directions of the velocity and acceleration? Explain how you can tell.



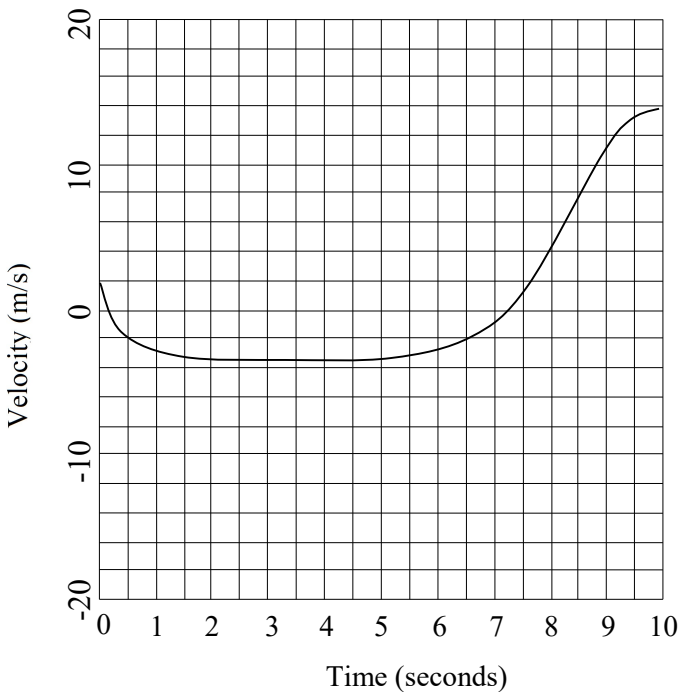
prediction for the position-, velocity-, and acceleration-time graphs that will be produced. Complete each example individually and then compare your predictions with the group. Note: It may be easiest to start with the v-t graph and the acceleration-time graph is new!

	1	2	3	4
Description	The cart is released from rest near the motion detector. The detector is at the top of the ramp.	The cart is moving towards the detector. The detector is at the top of the ramp.	The cart is moving away from the detector. The detector is at the bottom of the ramp.	The cart is released from rest far from the detector. The detector is at the bottom of the ramp.
Cart & Ramp Diagram with direction of Force				
Position graph				
Velocity graph				
Acceleration graph				
Slowing down or speeding up?				

4. Use your chart to help explain what the sign of the acceleration represents.

Homework: SU/SD

1. Answer the following questions based on the graph. Provide a brief explanation how you could tell.



   a) At what times, if any does the object have a positive acceleration and a negative velocity?

   b) At what times, if any does the object have a negative acceleration and a positive velocity?

   c) At what times, if any, was the acceleration zero?

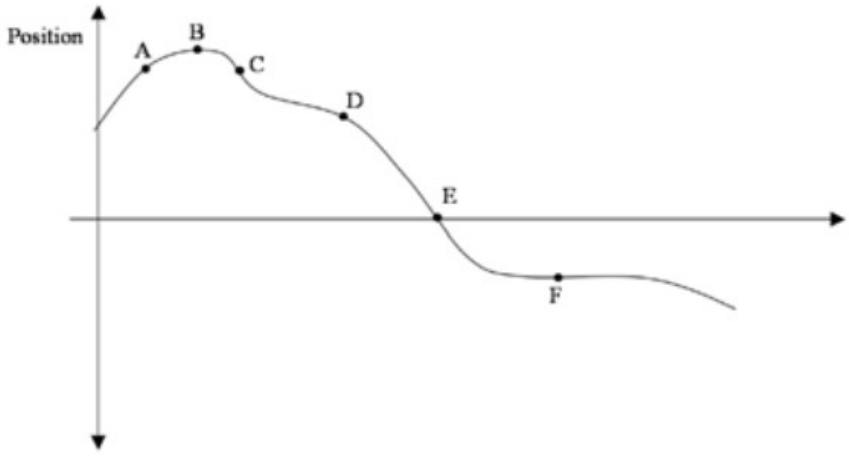
   d) At what times, if any, was the object speeding up?

   e) At what times, if any, was the object slowing down?

   f) At what times, if any, did the object sit still for an extended period of time?

   g) Overall, is the motion in the graph an example of uniform or nonuniform acceleration?

2. Answer the following questions based on the graph. Provide a brief explanation how you could tell. At which of the lettered points on the graph below:
   a) is the motion slowest?



b) is the object speeding up?

c) is the object slowing down?

d) is the object turning around?

3. A car's velocity changes from +40 km/h to +30 km/h in 3 seconds. Is the acceleration positive or negative? Find the acceleration.

4. At the beginning of a half-hour time period, a snail is moving at -3.0 mm/s. The snail then slows down, turns around and starts heading back in the opposite direction at +1.0 mm/s. Is the acceleration positive or negative? Find the acceleration.

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