

January 25, Week 2

Today: Chapter 2, Instantaneous Velocity and Acceleration

Homework Assignment #2 - Due Today

Mastering Physics: 6 problems from chapters 1 and 2.

Written Question: 2.75

Homework Assignment #3 - Due February 1

Mastering Physics: 6 problems from chapter 2.

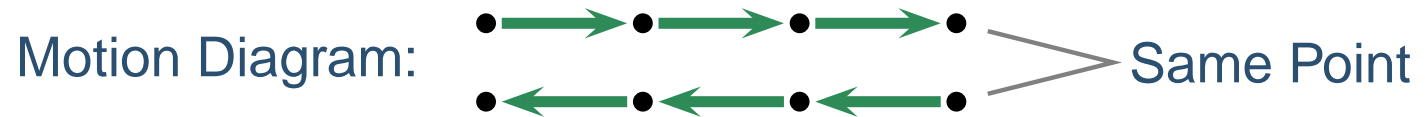
Written Question: 2.88

Please put box number on your homework

Friday office hours will be held in Regener Hall 114

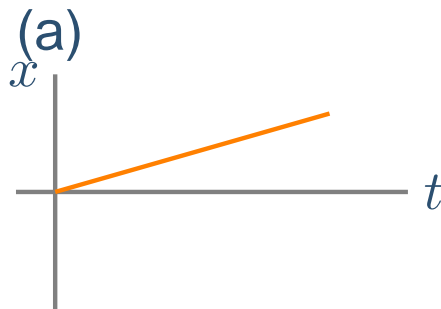
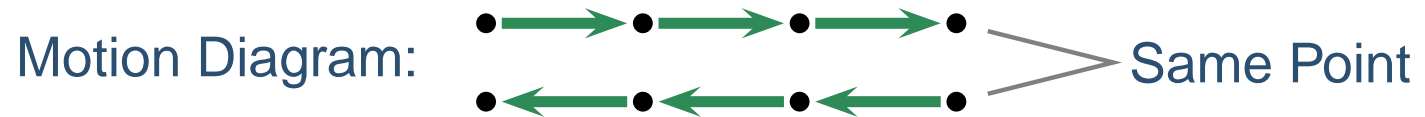
Position Graph Exercise

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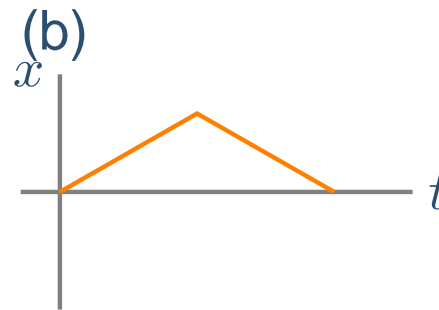
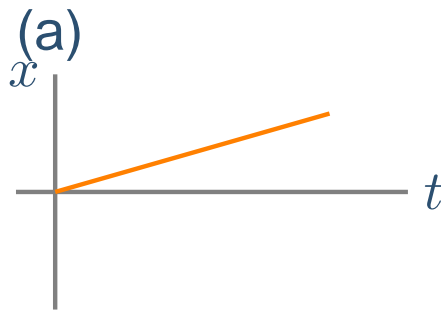
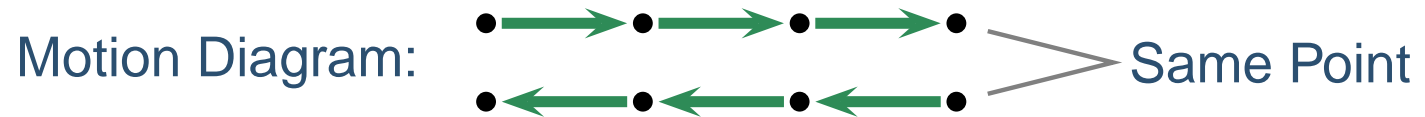
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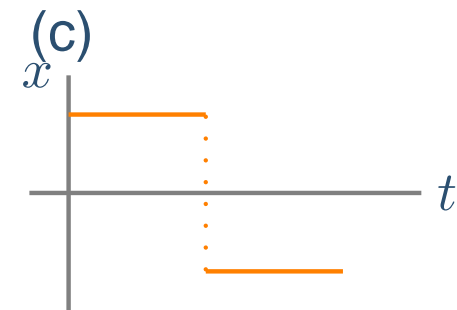
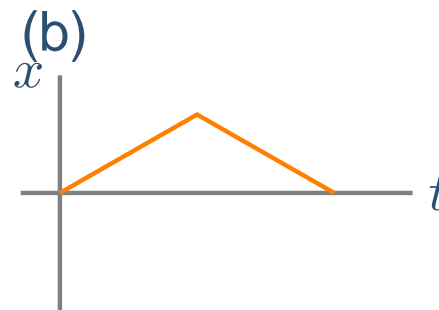
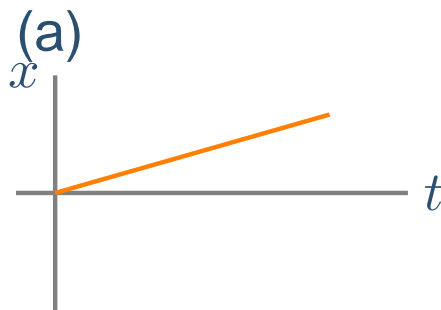
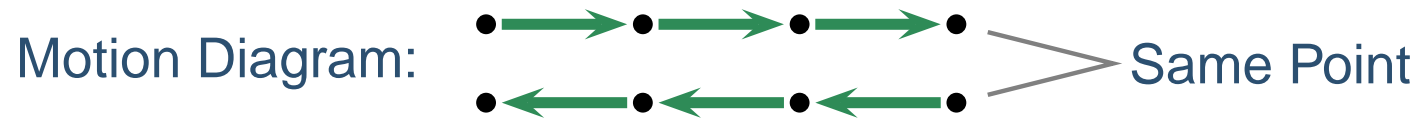
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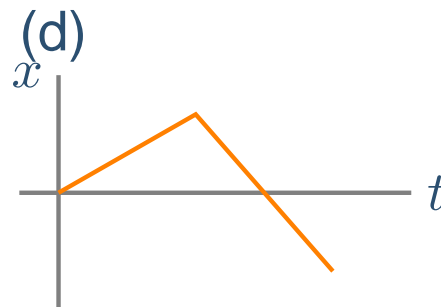
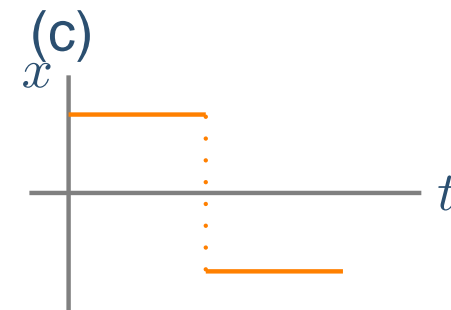
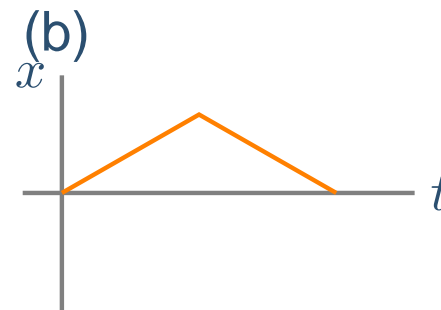
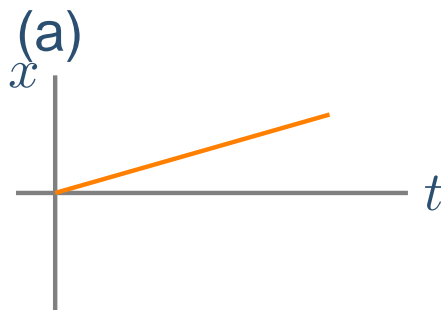
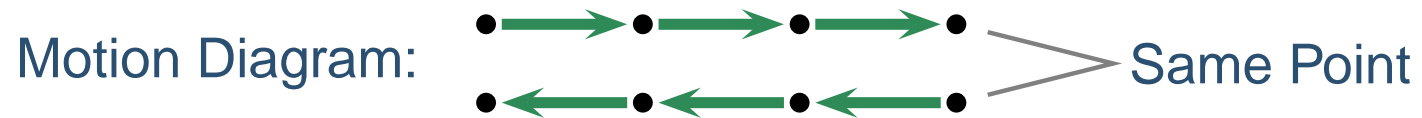
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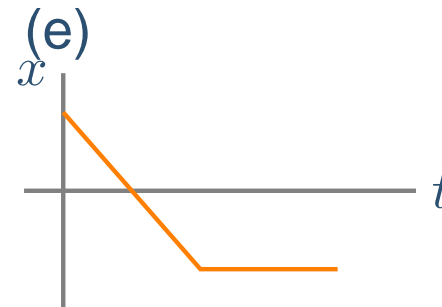
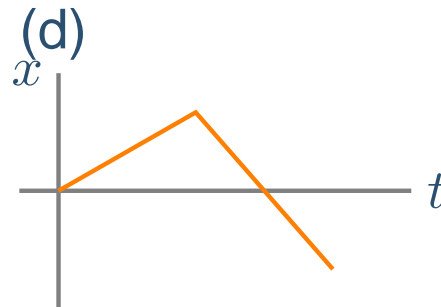
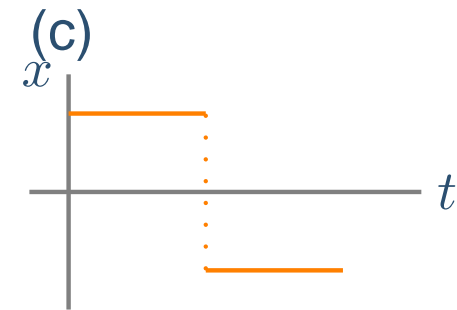
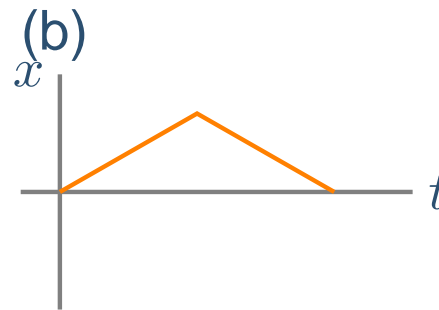
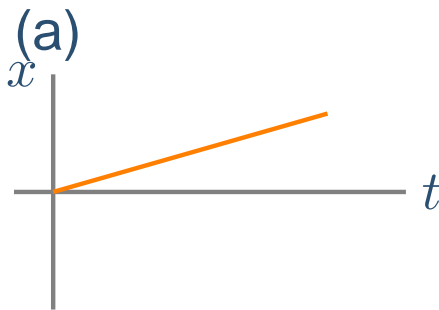
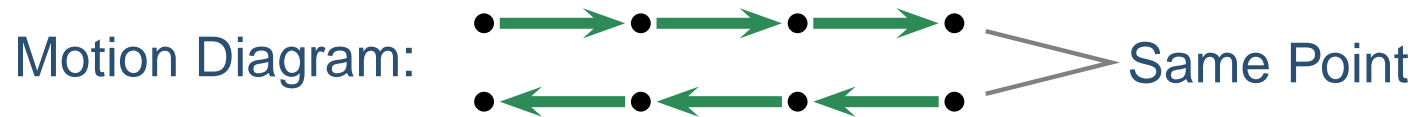
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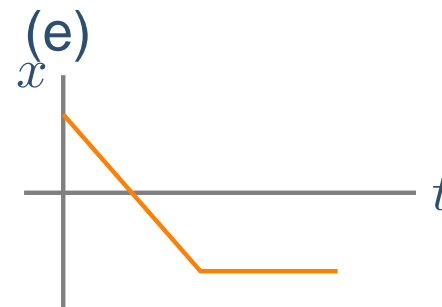
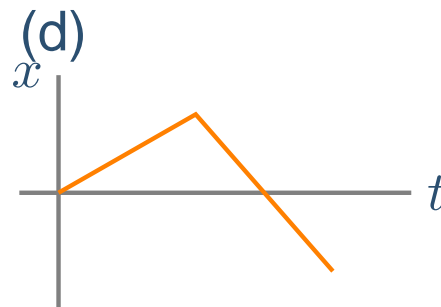
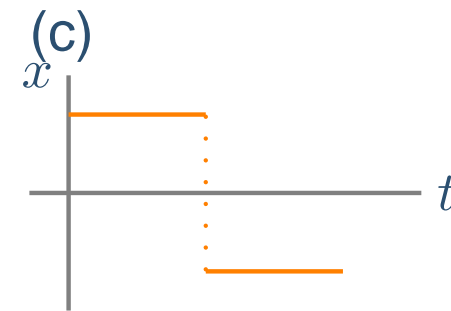
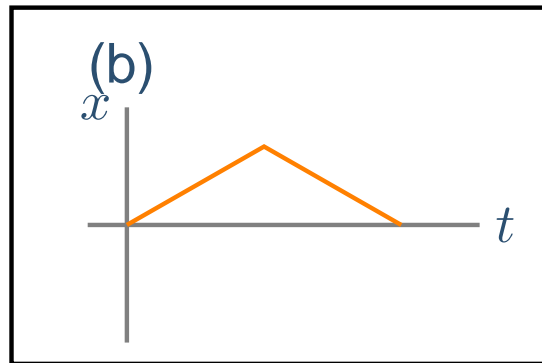
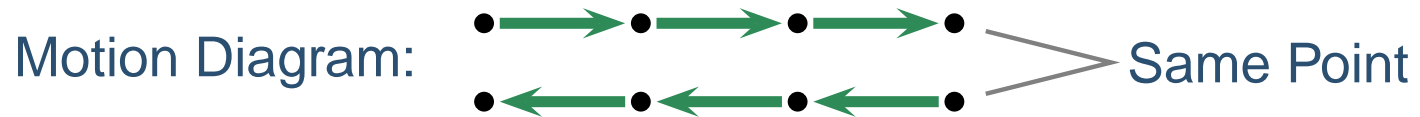
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Position Graph Followup

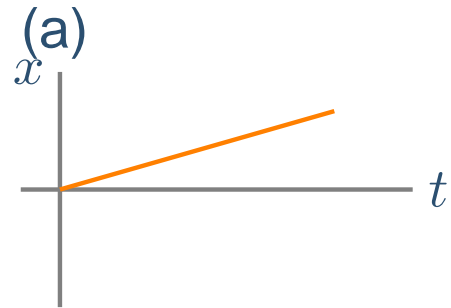


Position Graph Followup

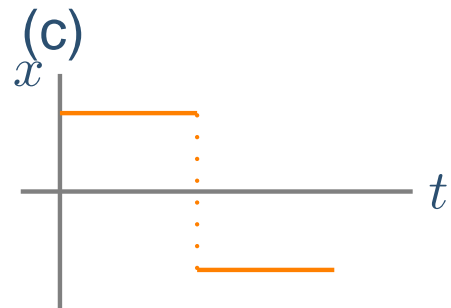


Man walks to the right with constant speed the whole time

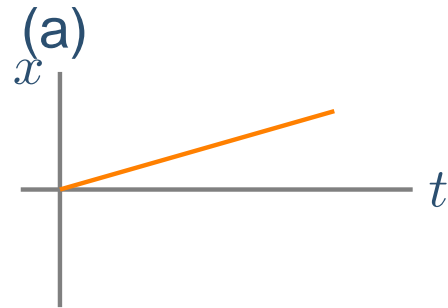
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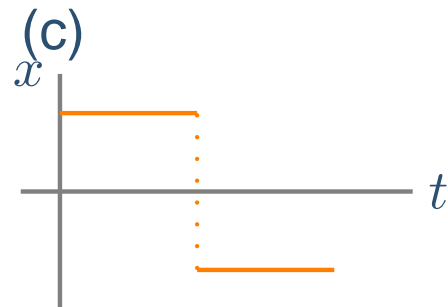
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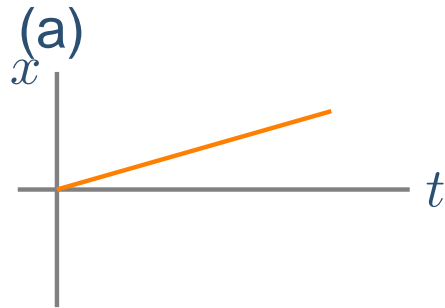


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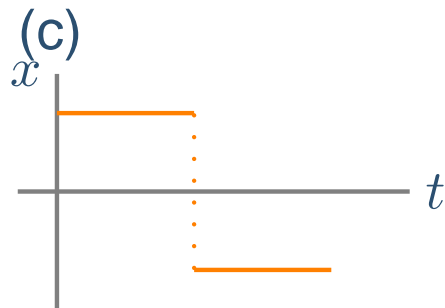


Man stands to the right of origin, magically appears to left of origin, stands there.

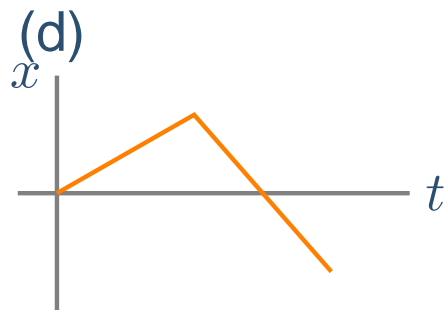
Position Graph Followup



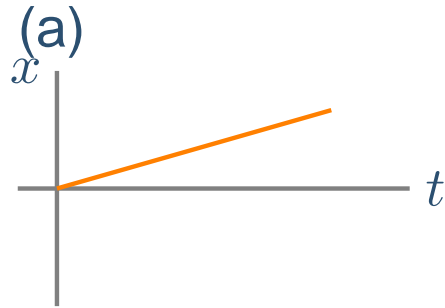
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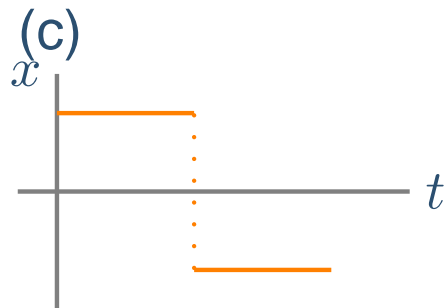
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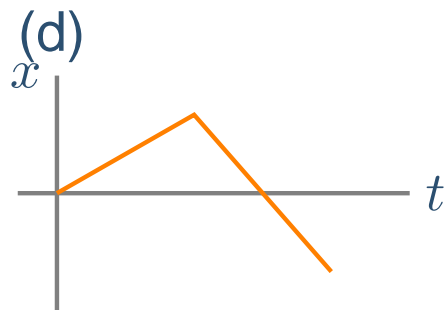
Position Graph Followup



Man walks to the right with constant speed the whole time

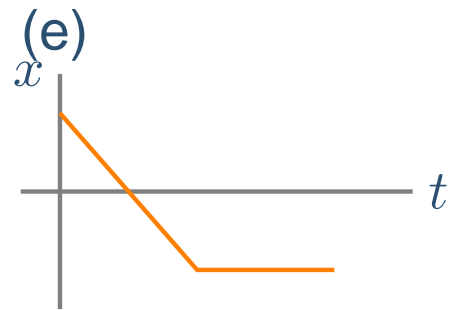


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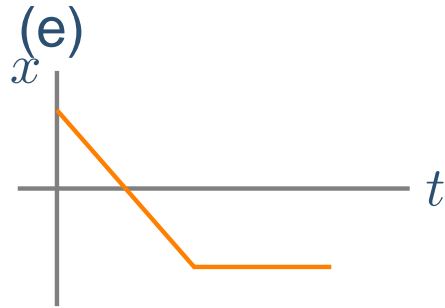


Man goes to the right with constant speed. Man turns around. Man goes to the left with faster speed and crosses origin.

Position Graph Followup II

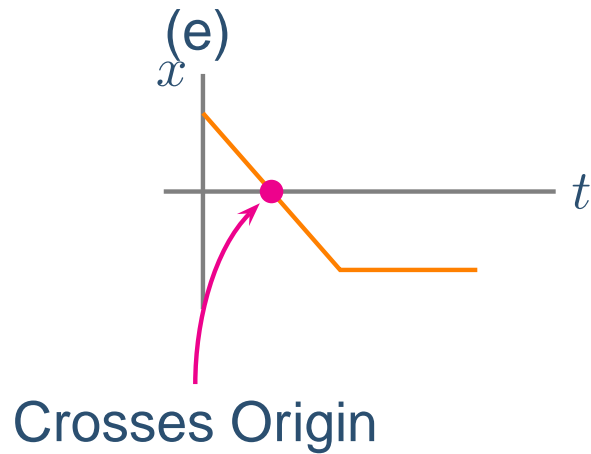


Position Graph Followup II



Man starts to the right of origin. Walks to left with constant speed. Passes origin. Stands in place.

Position Graph Followup II



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Uniform Motion Velocity Graph

The simplest graph is the velocity versus time for uniform motion.

Uniform Motion Velocity Graph

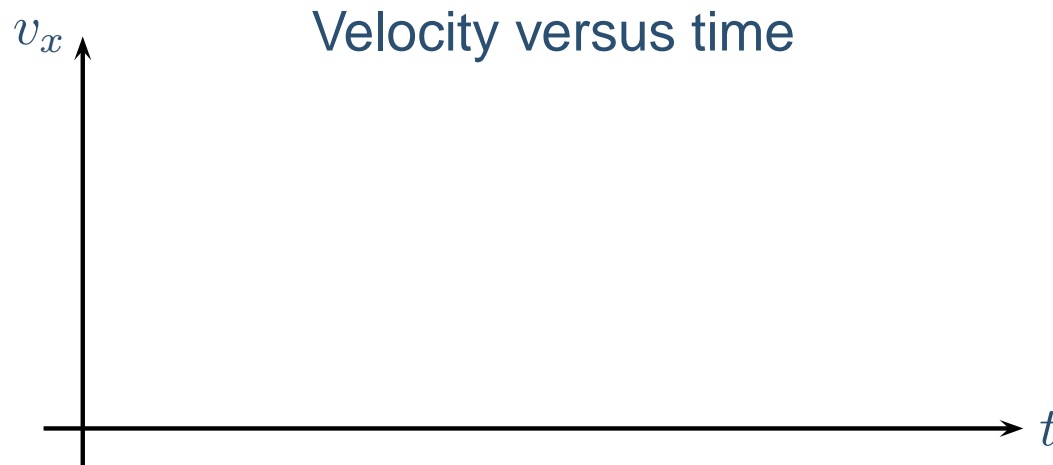
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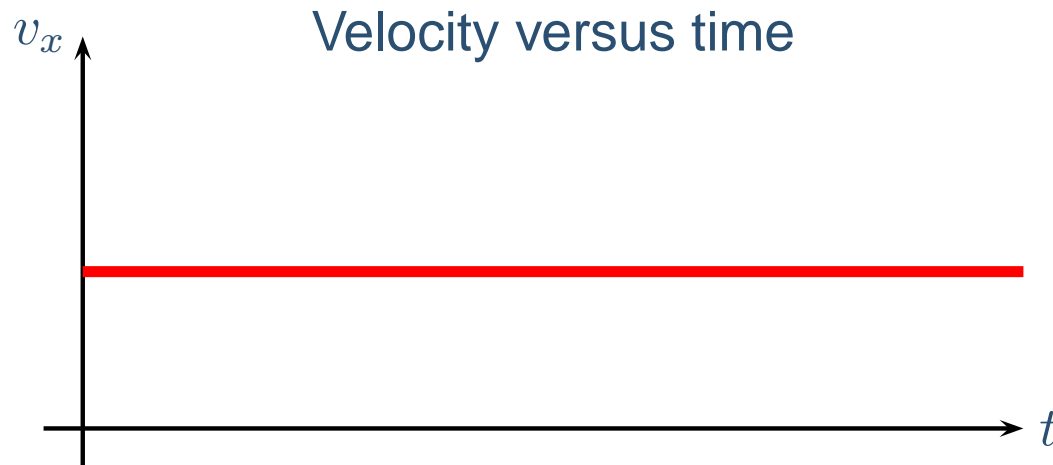
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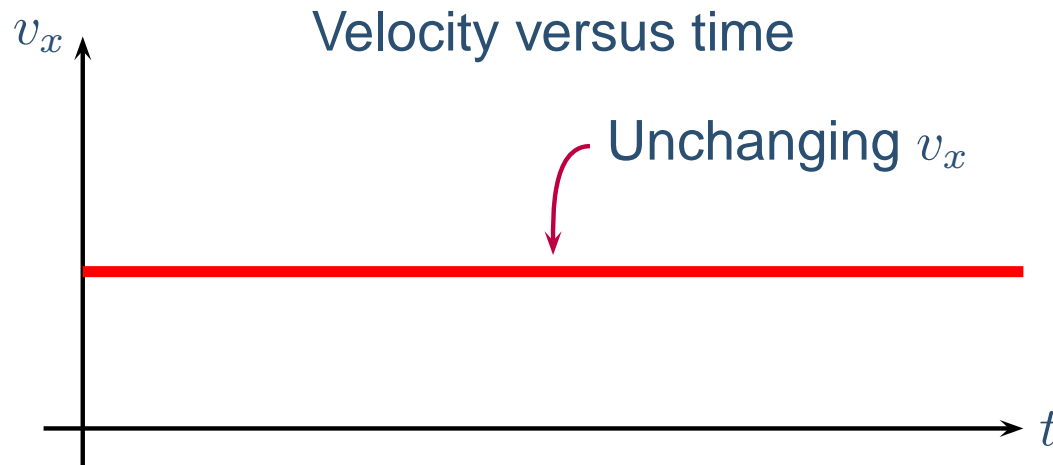


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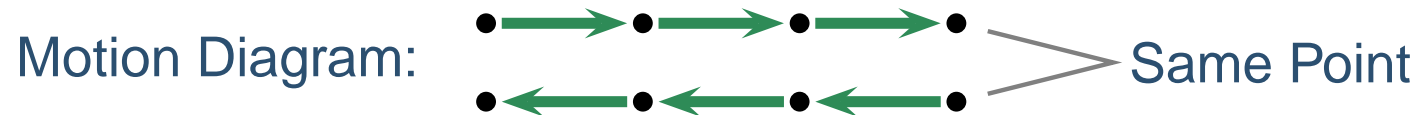
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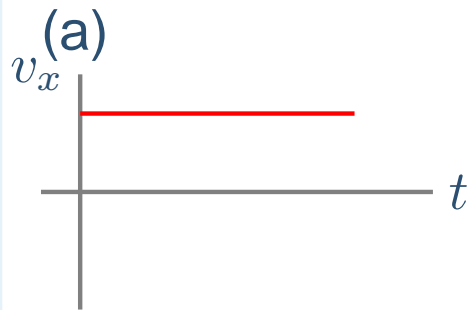
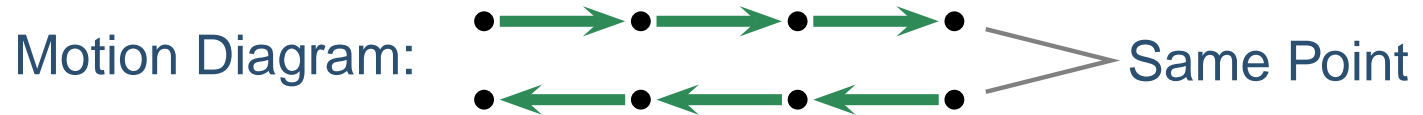
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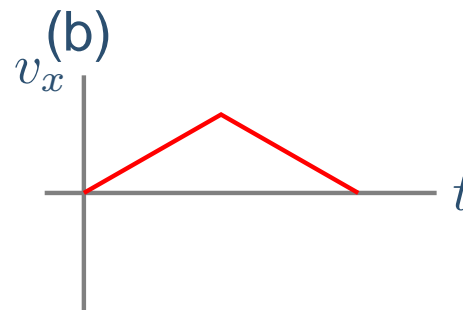
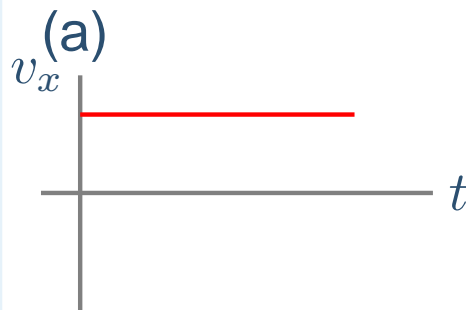
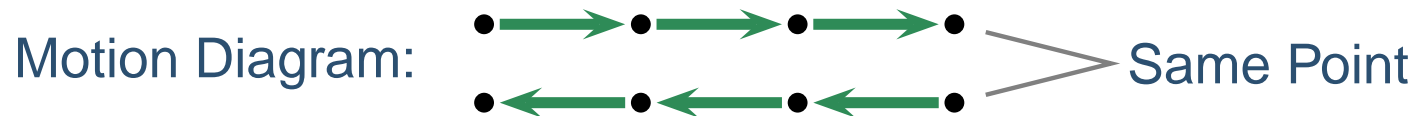
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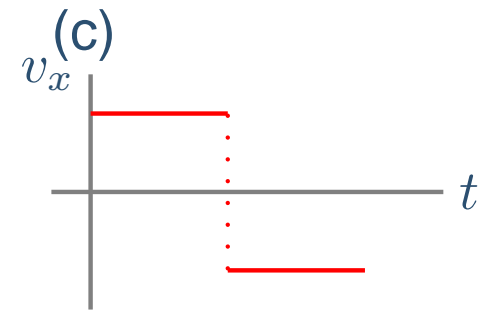
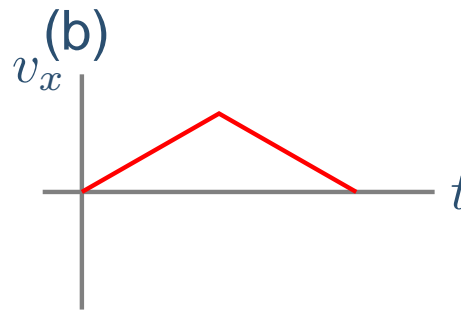
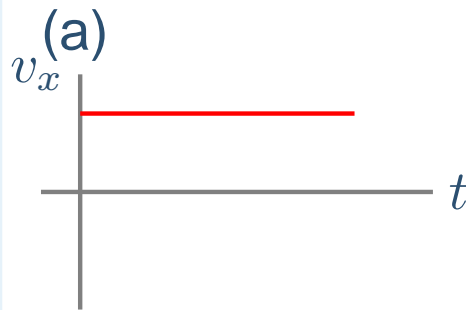
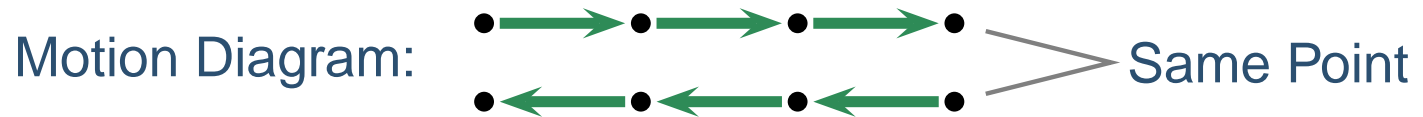
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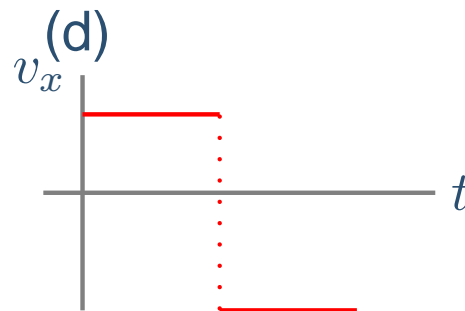
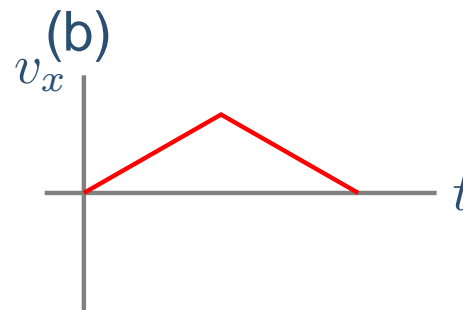
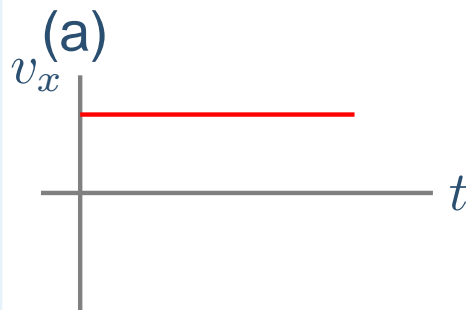
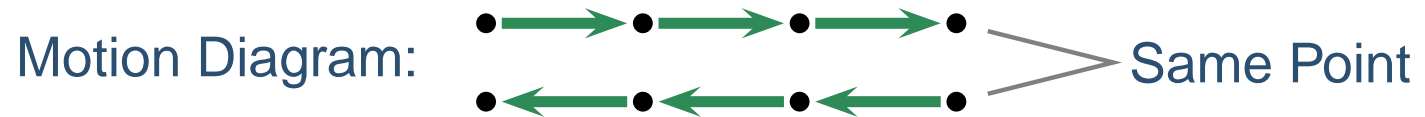
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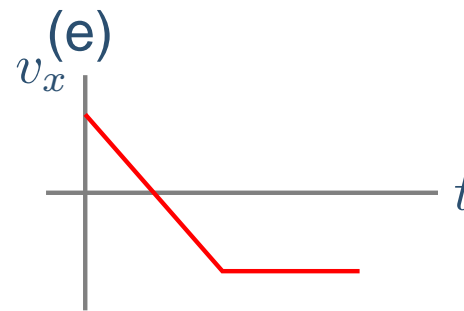
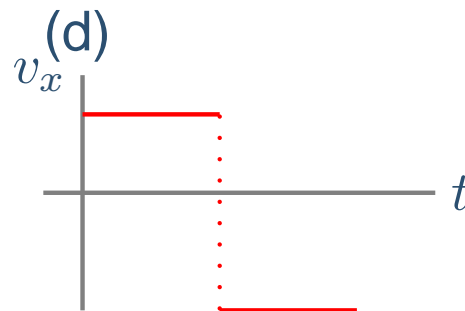
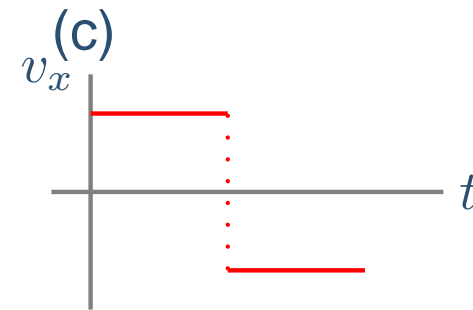
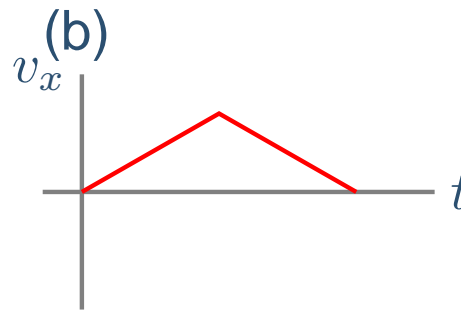
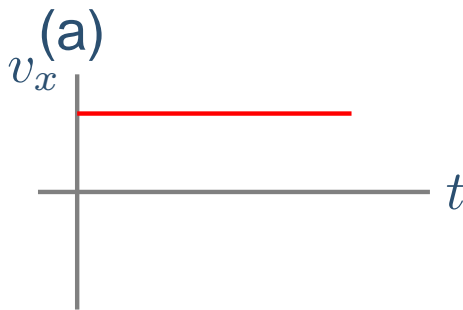
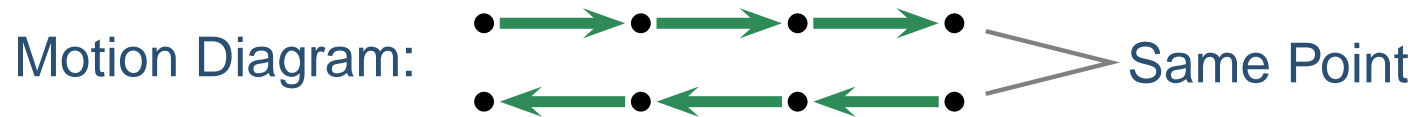
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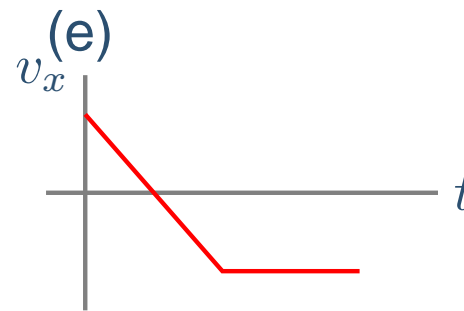
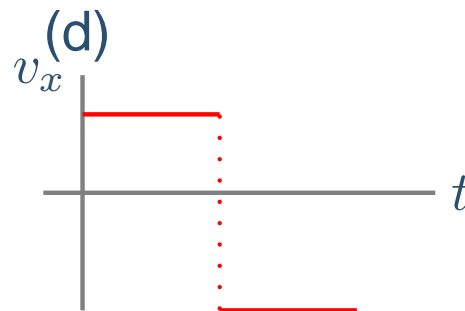
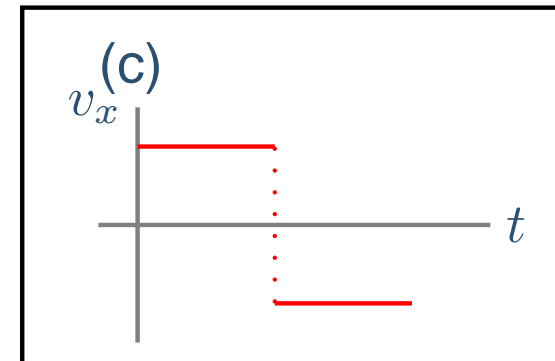
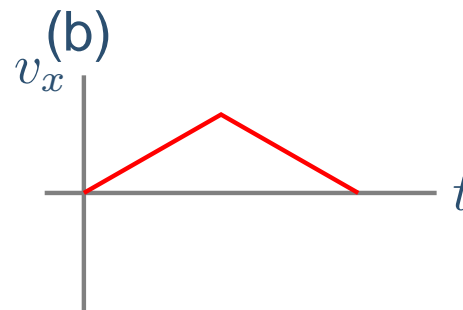
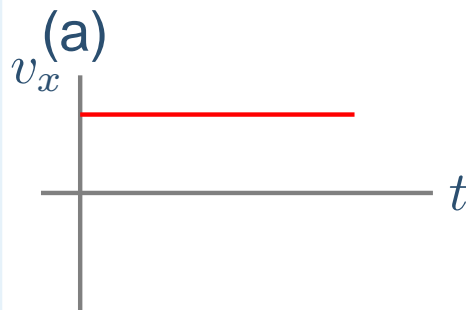
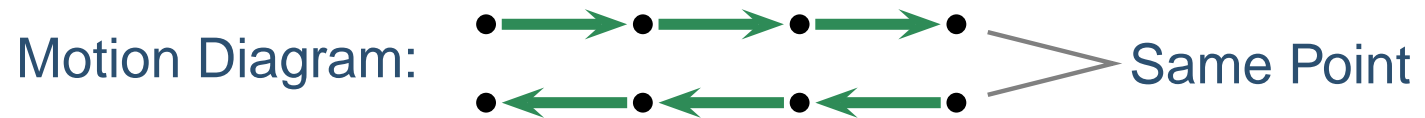
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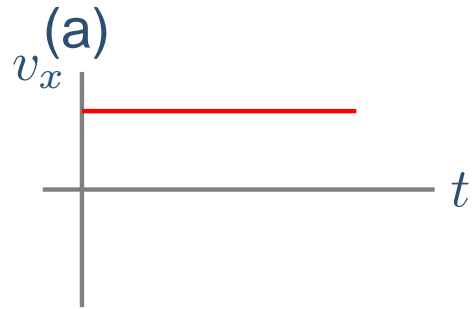


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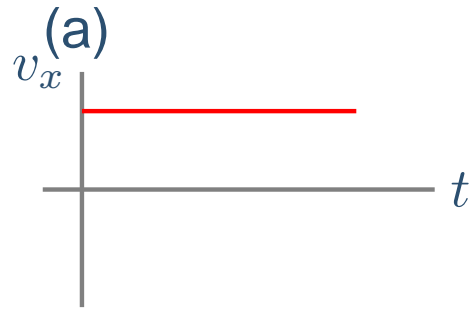
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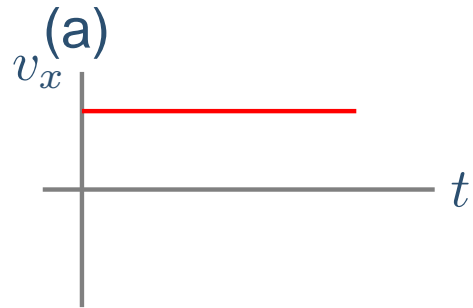


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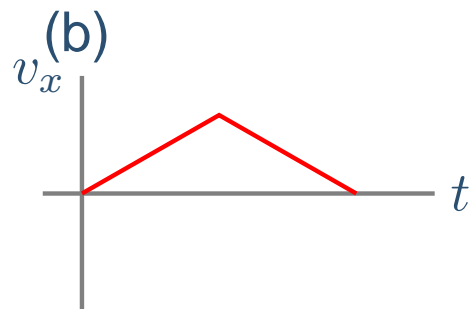


Man walks to the right with constant speed the whole time

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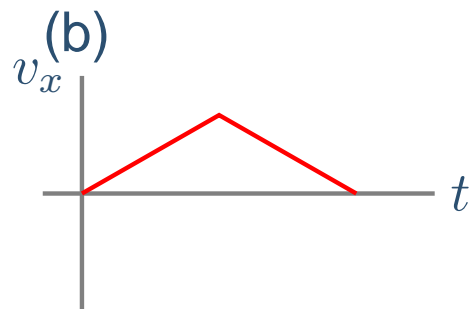
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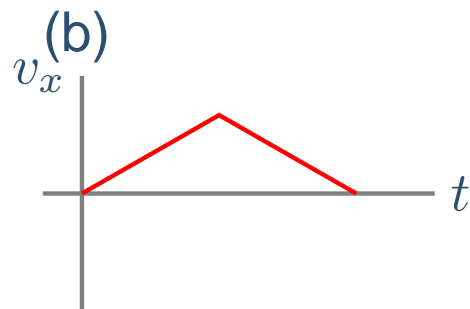


Man speeds up then the man slows down. Going to the right the whole time.

Velocity Graph Followup



Man walks to the right with constant speed the whole time



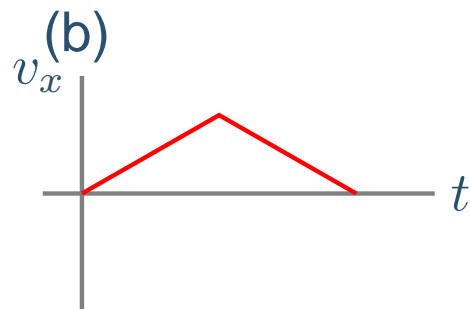
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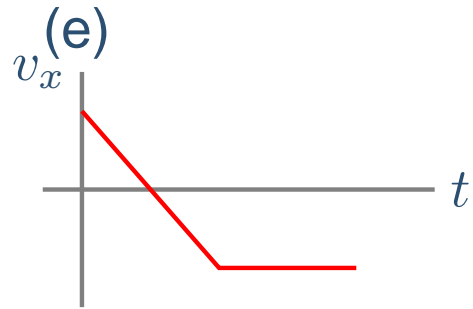


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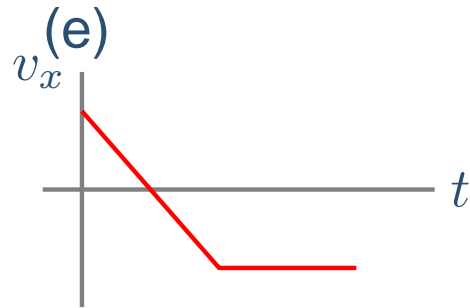


Man goes to the right with constant speed. Man immediately turns around. Man goes to the left with faster speed.

Velocity Graph Followup II

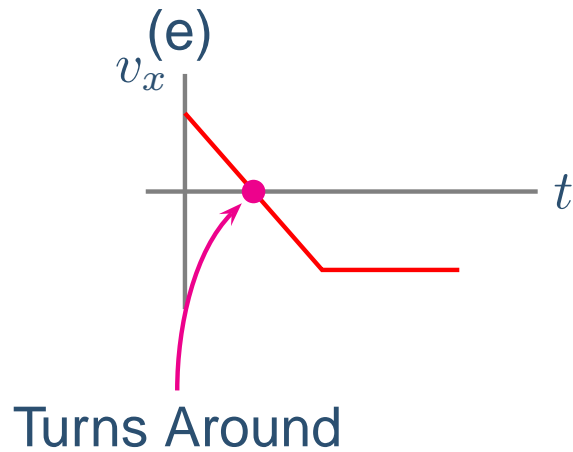


Velocity Graph Followup II



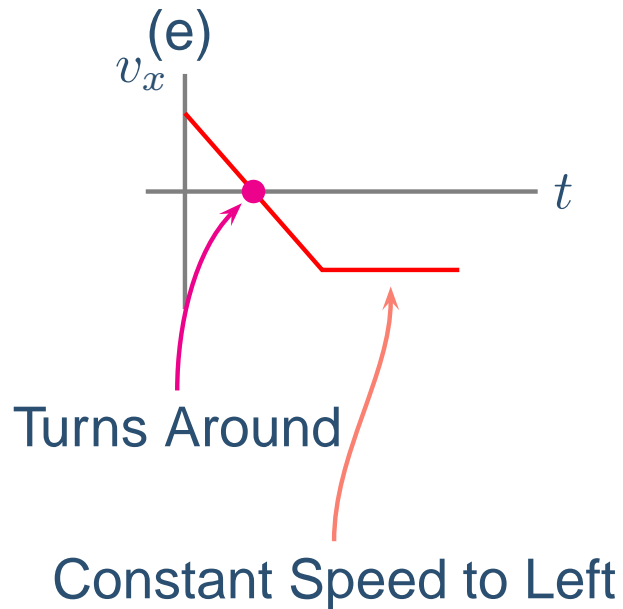
Man walks to the right but slowing down. Eventually he turns around. Goes to the left with increasing speed and then maintains constant speed to the left.

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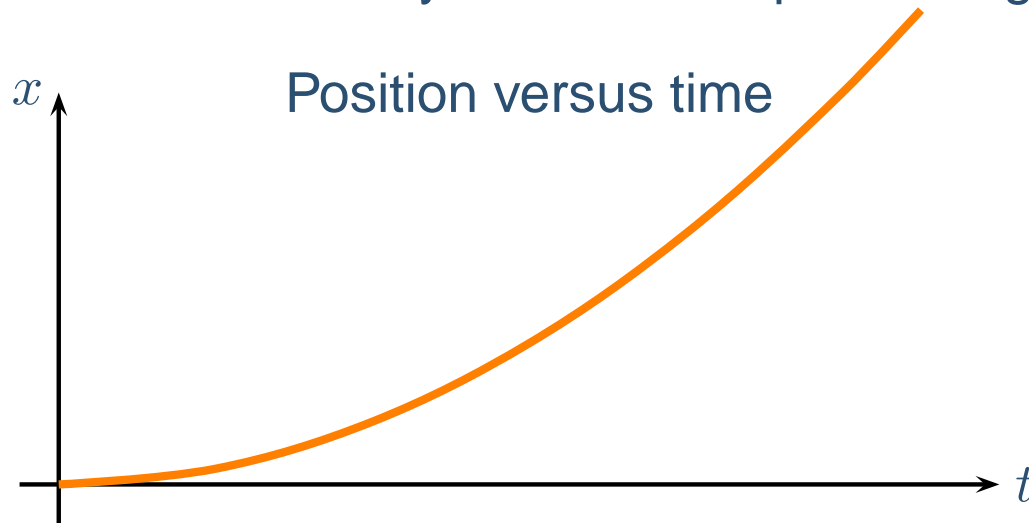
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Changing Velocity

When velocity is changing, position versus time is now a curve. Instantaneous velocity is still the slope of the graph.

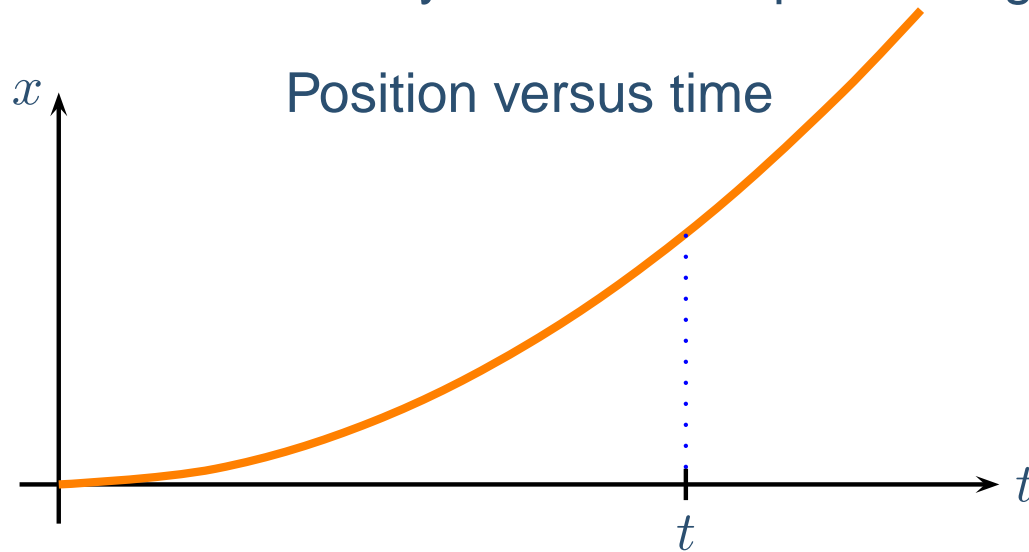
Changing Velocity

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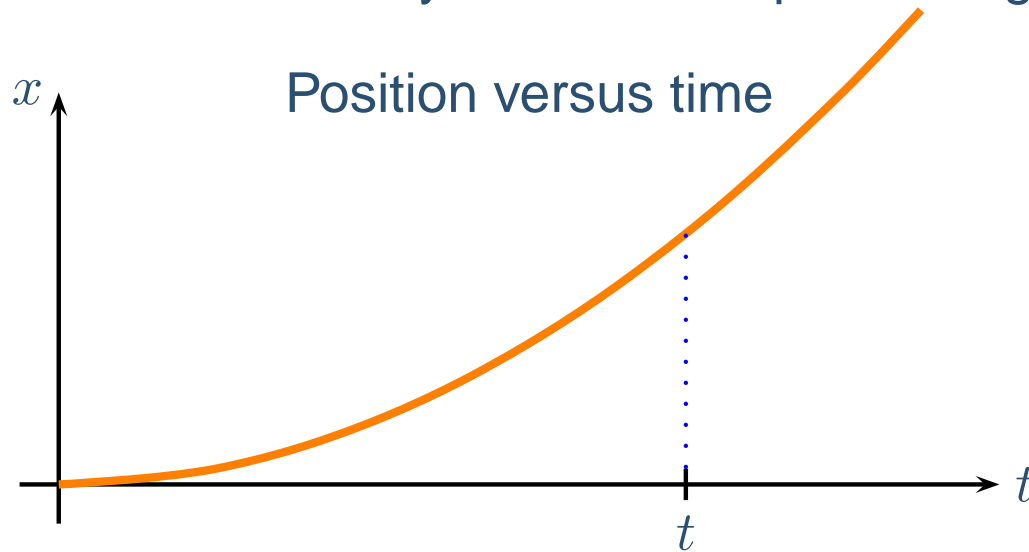
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Changing Velocity

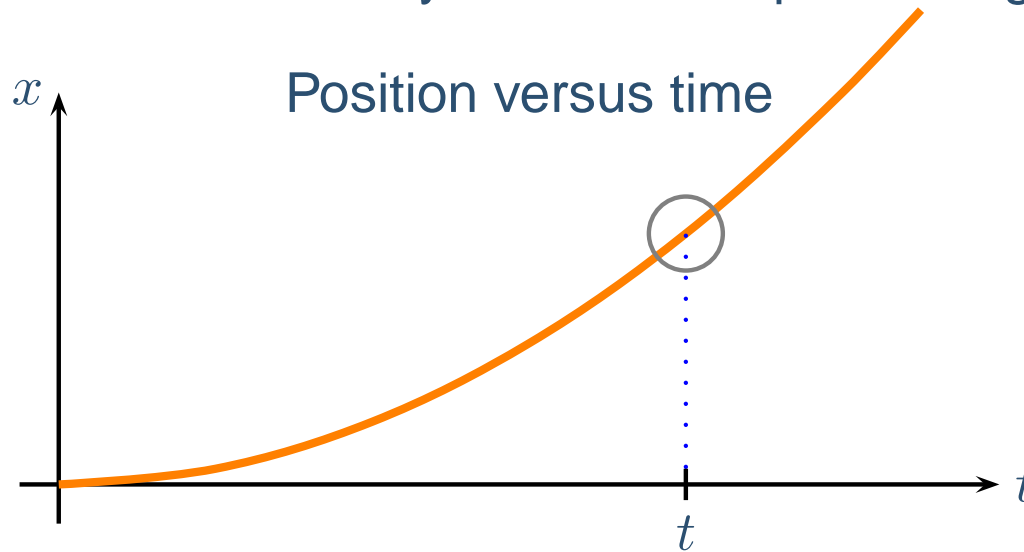
When velocity is changing, position versus time is now a curve. Instantaneous velocity is still the slope of the graph.



To find the velocity at one time t we use the fact that all curves look straight when magnified

Changing Velocity

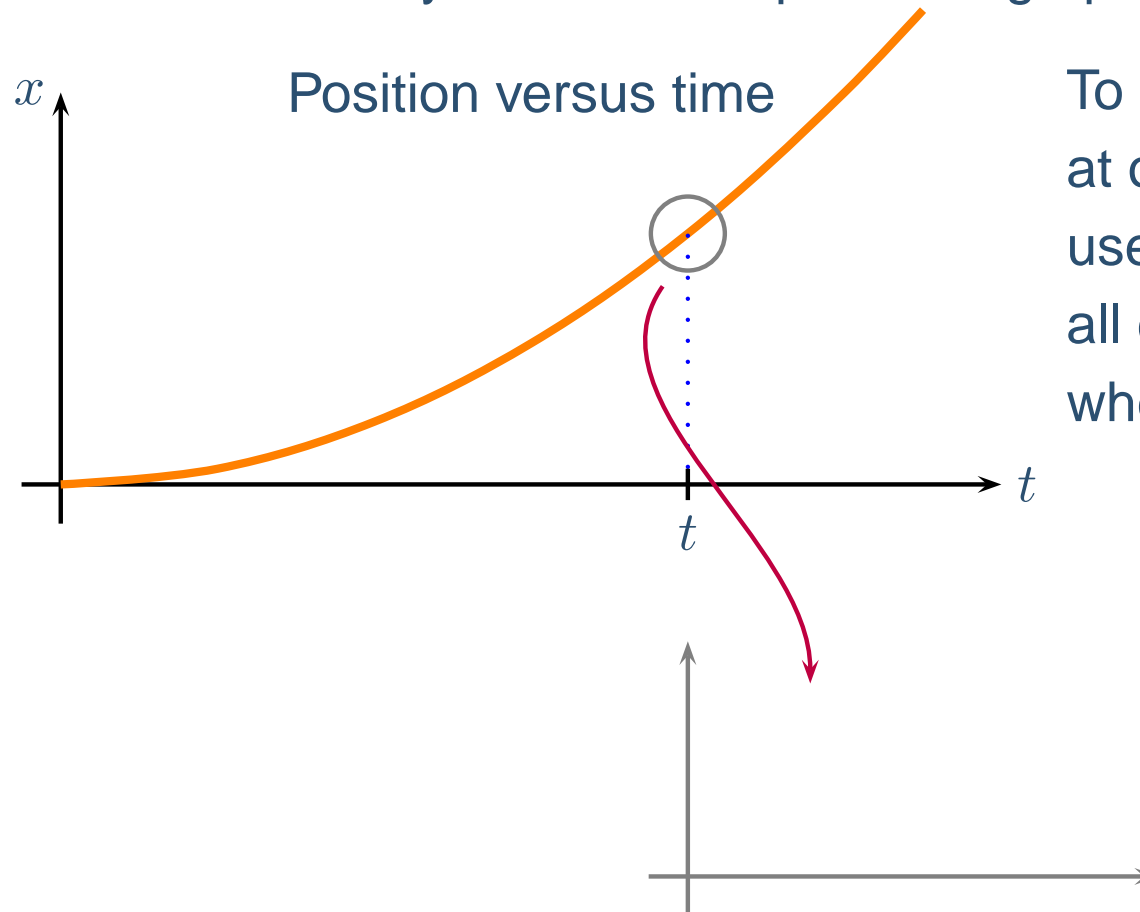
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Changing Velocity

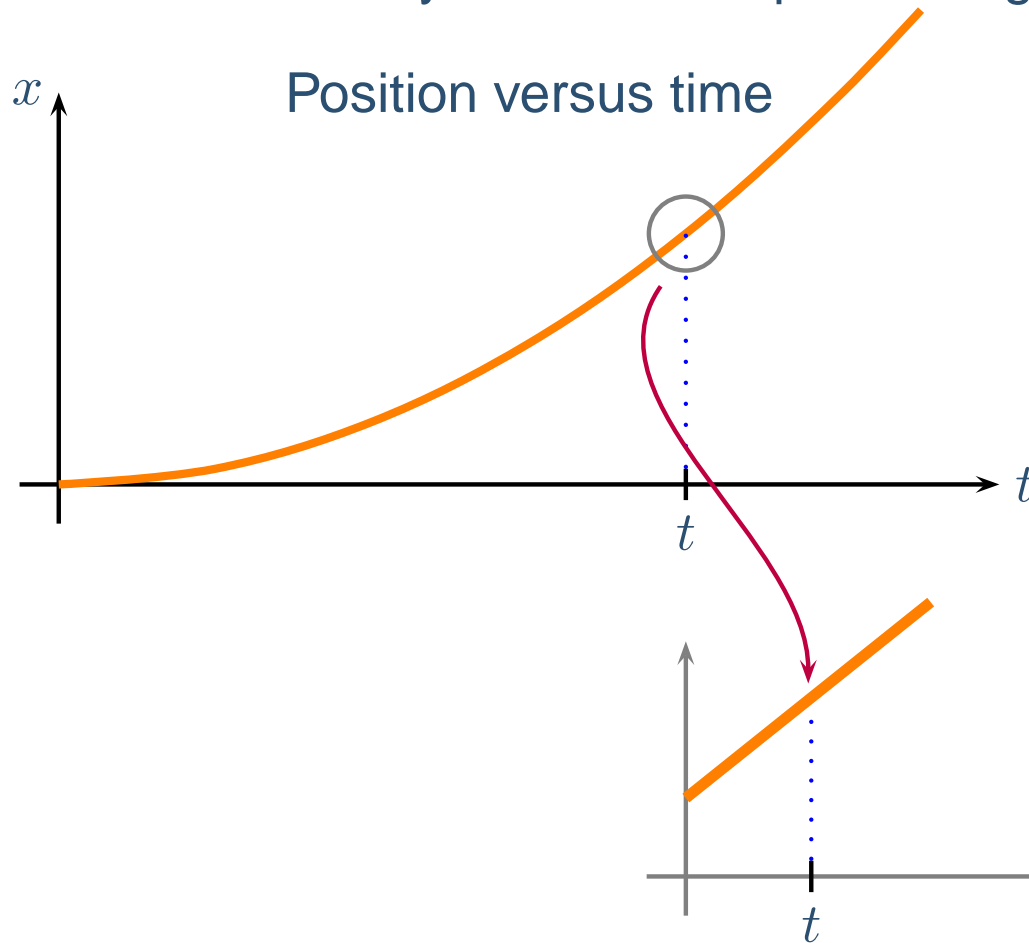
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Changing Velocity

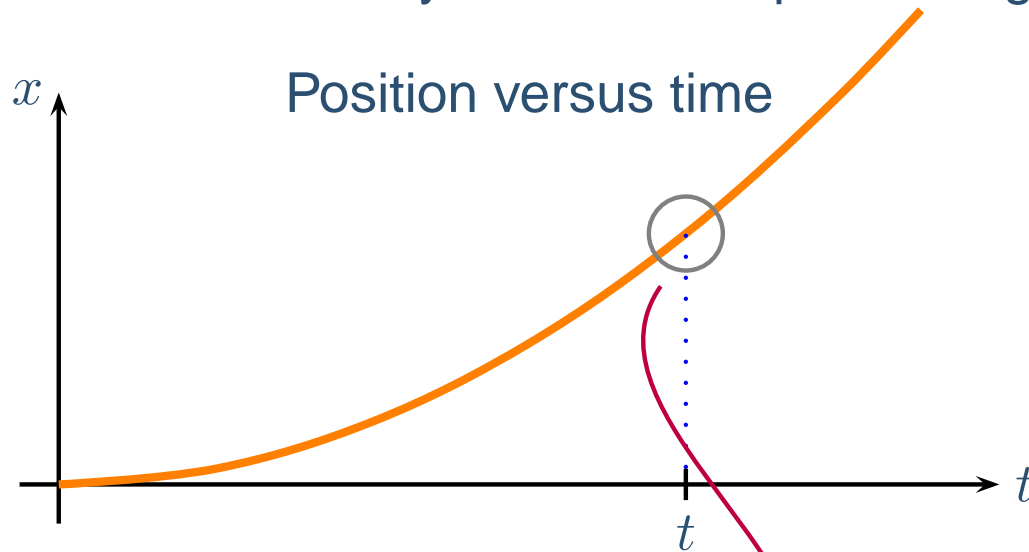
When velocity is changing, position versus time is now a curve. Instantaneous velocity is still the slope of the graph.



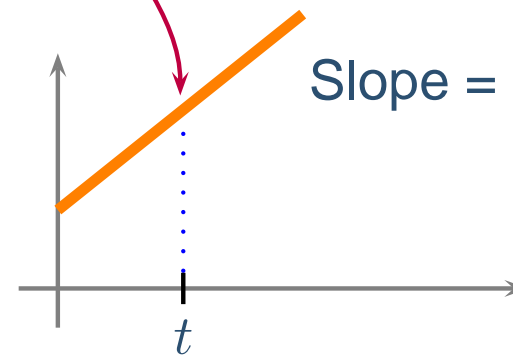
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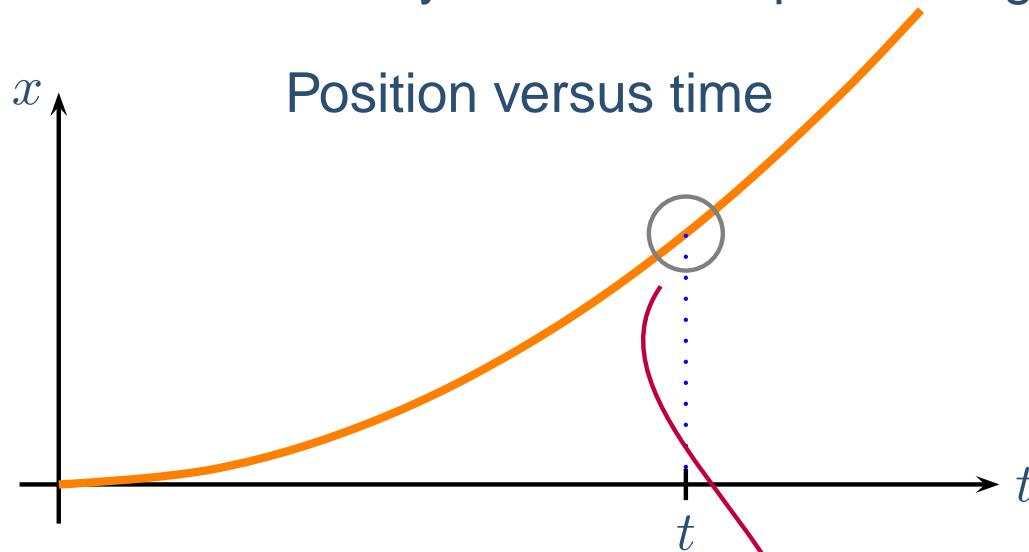
To find the velocity at one time t we use the fact that all curves look straight when magnified



Slope = Velocity at time t

Changing Velocity

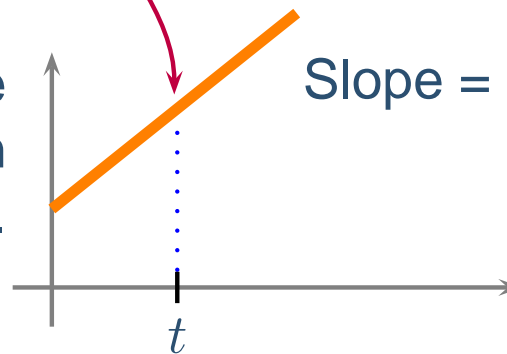
When velocity is changing, position versus time is now a curve. Instantaneous velocity is still the slope of the graph.



To find the velocity at one time t we use the fact that all curves look straight when magnified

Note: To make this exact we have to make the magnification infinite by taking a derivative.

$$v_x = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

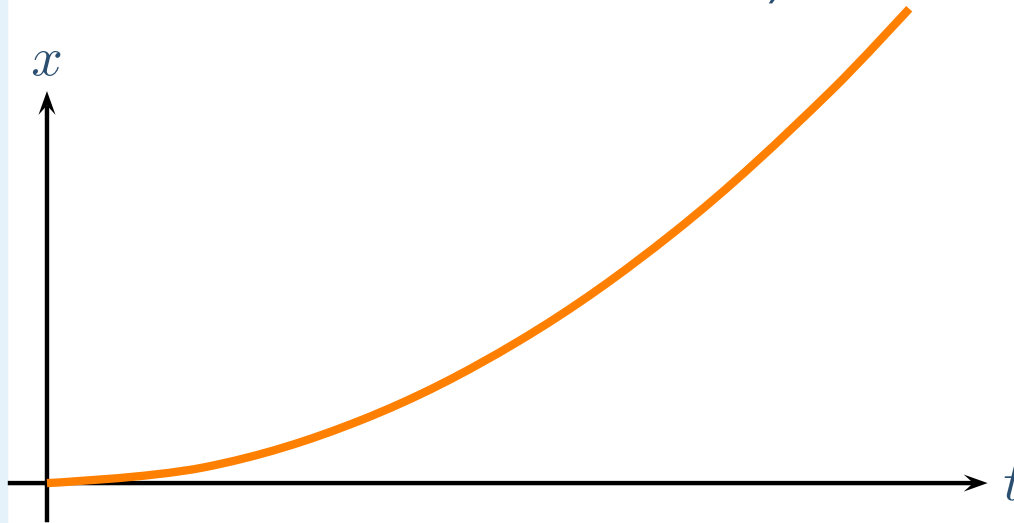


Changing Velocity II

At different points on the curve, the slopes are different (and therefore so are the velocities).

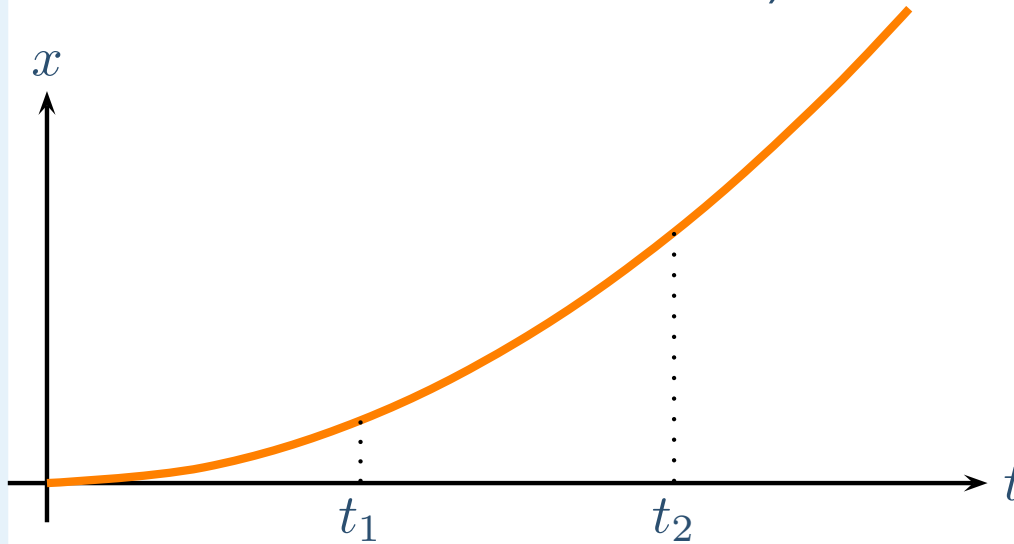
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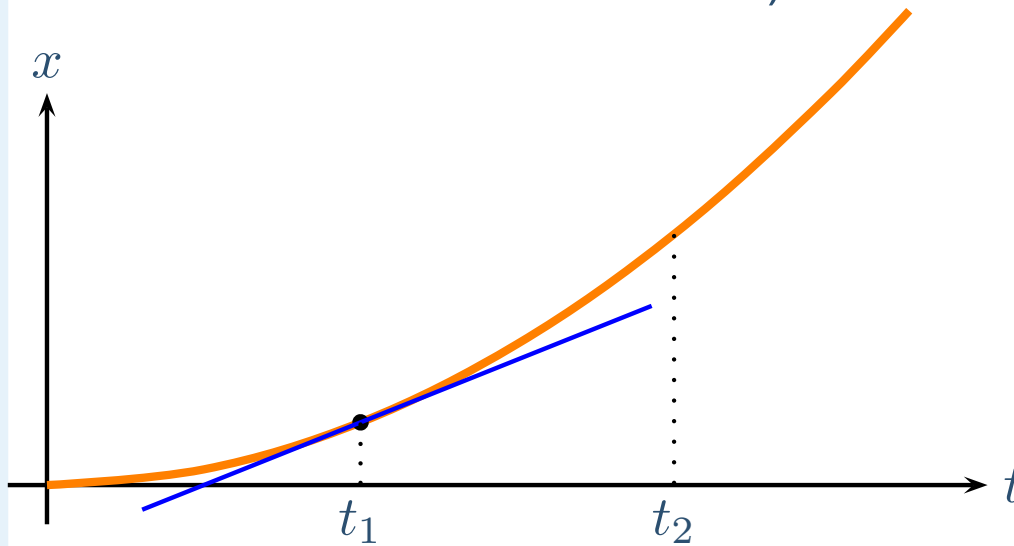
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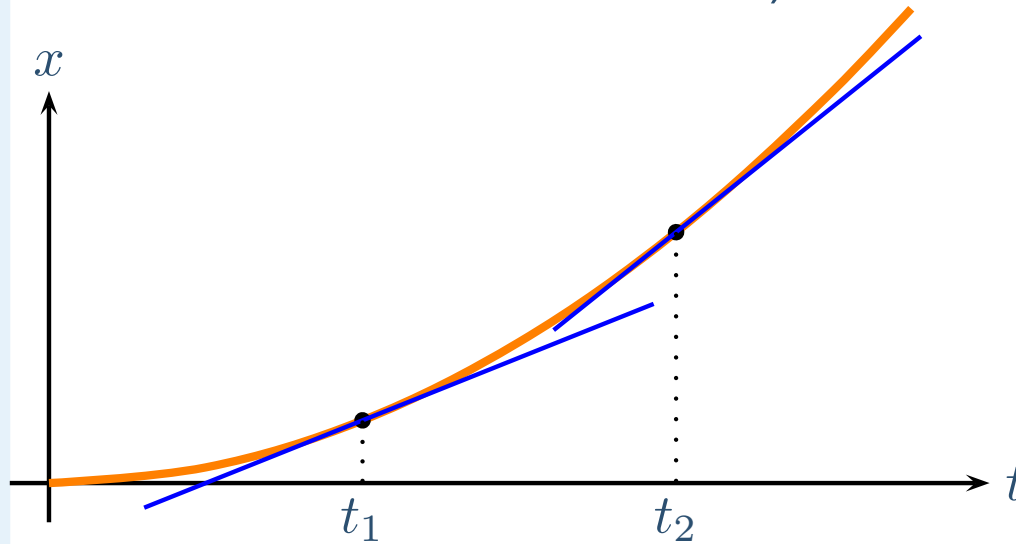
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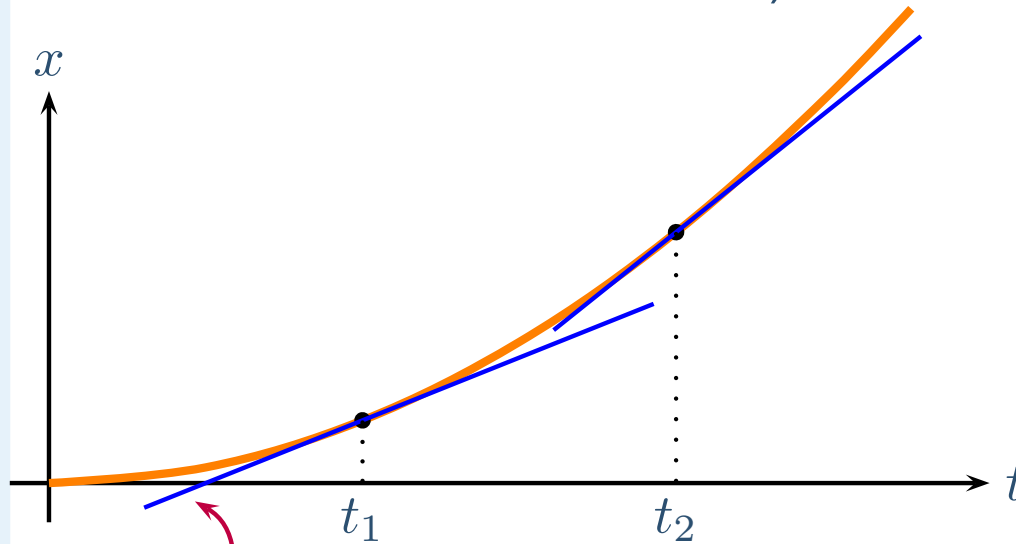
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Changing Velocity II

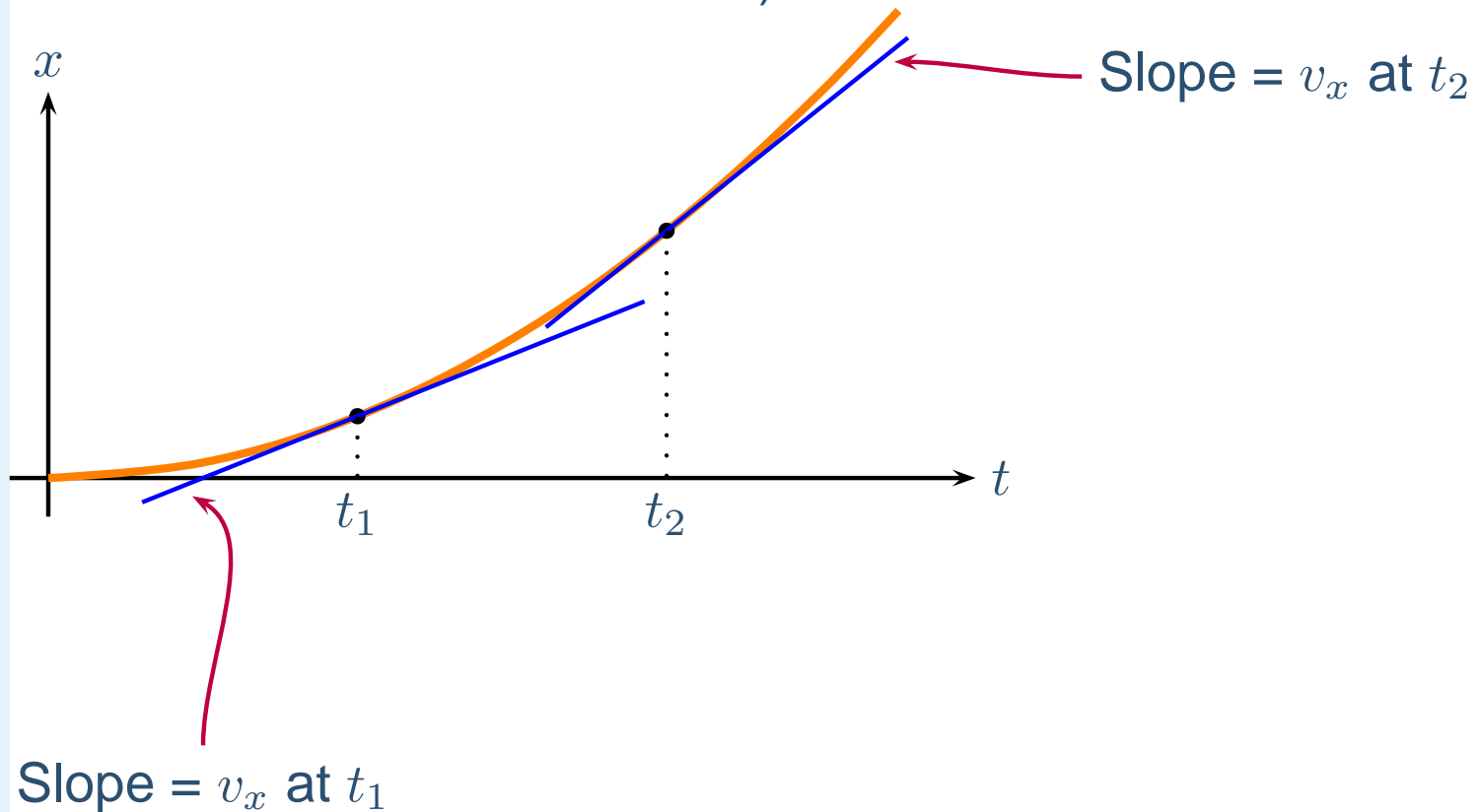
At different points on the curve, the slopes are different (and therefore so are the velocities).



Slope = v_x at t_1

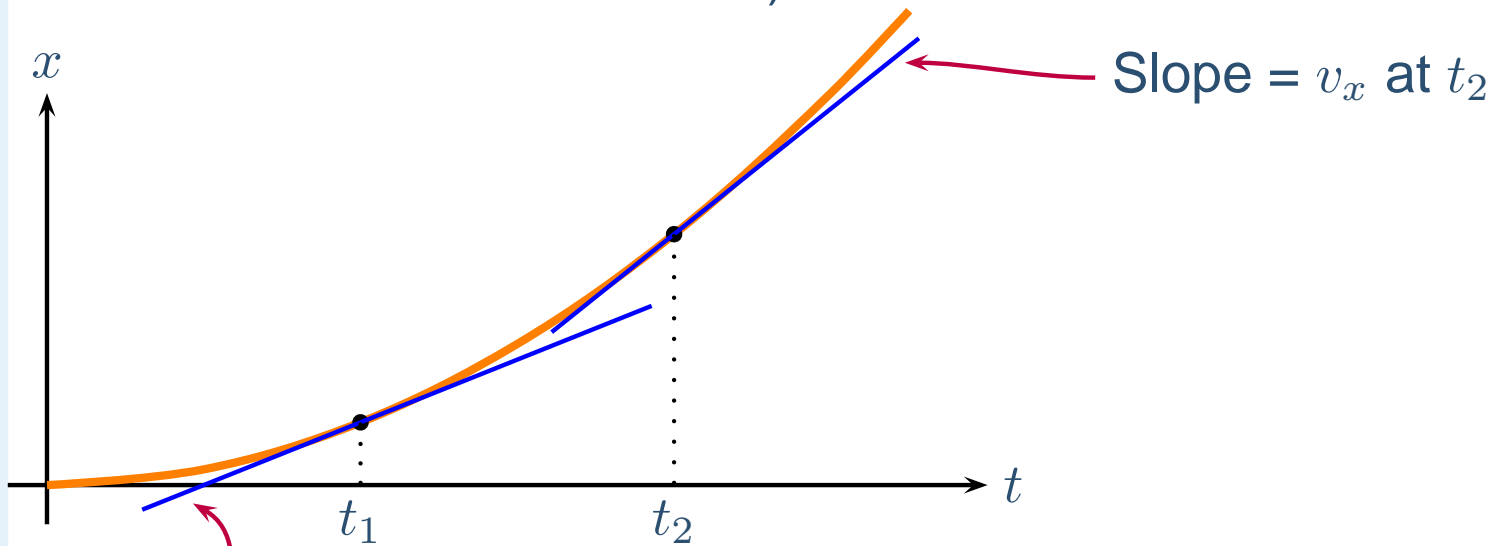
Changing Velocity II

At different points on the curve, the slopes are different (and therefore so are the velocities).



Changing Velocity II

At different points on the curve, the slopes are different (and therefore so are the velocities).



Slope = v_x at t_1

Slope = v_x at t_2

Positive slope values range from 0 to ∞

Horizontal lines have 0 slope

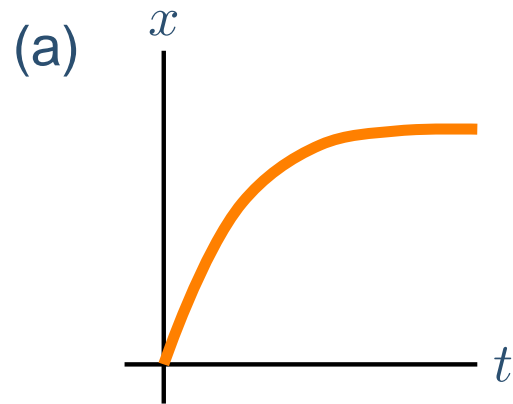
Vertical Lines have infinite slope

Velocity Exercise I

Which of the following position versus time graphs corresponds to an object which is slowing down?

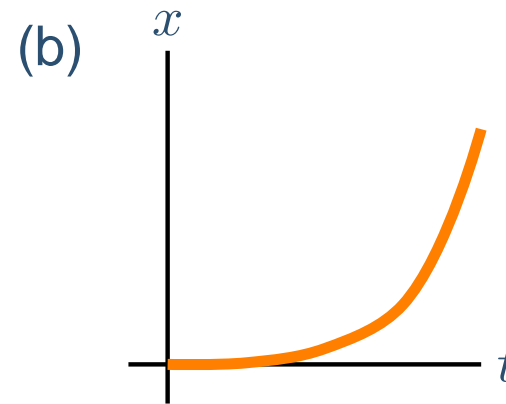
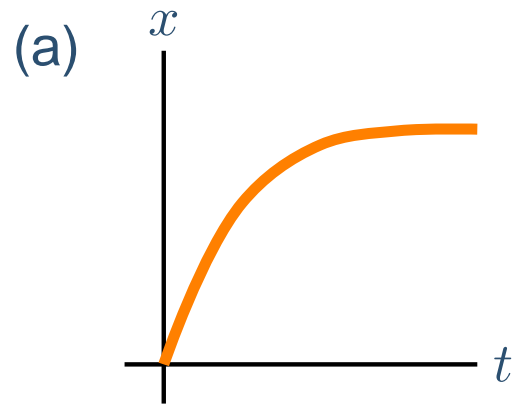
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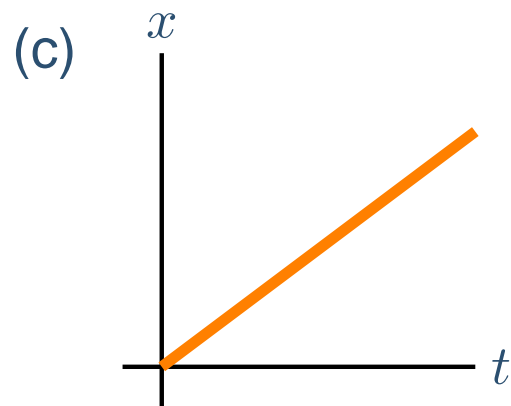
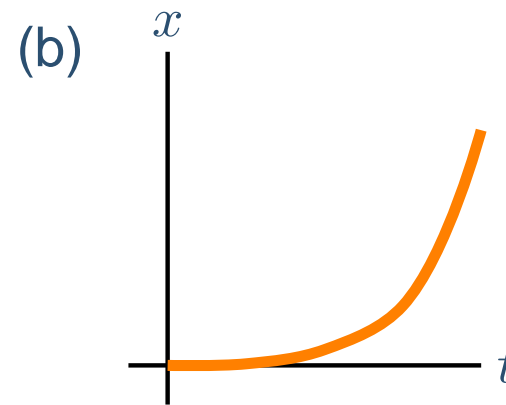
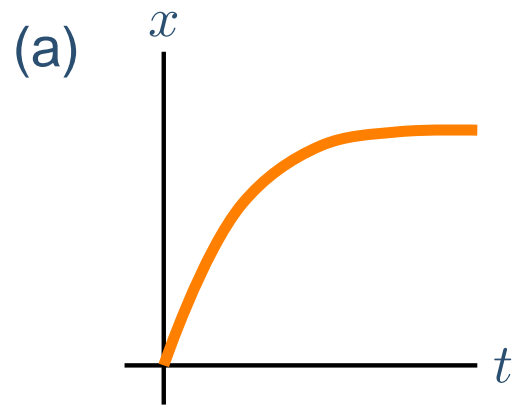
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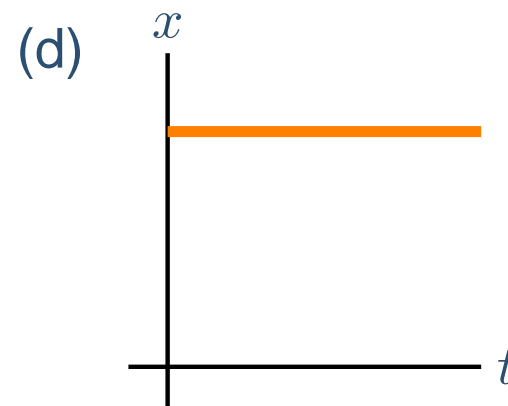
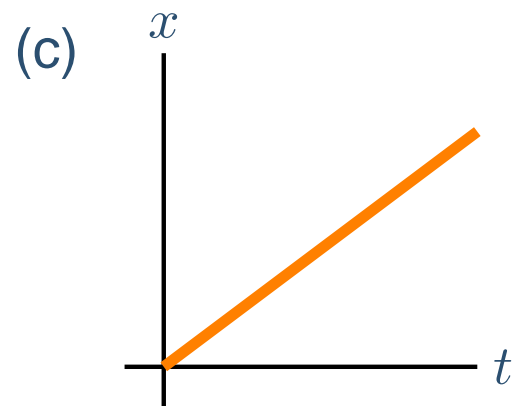
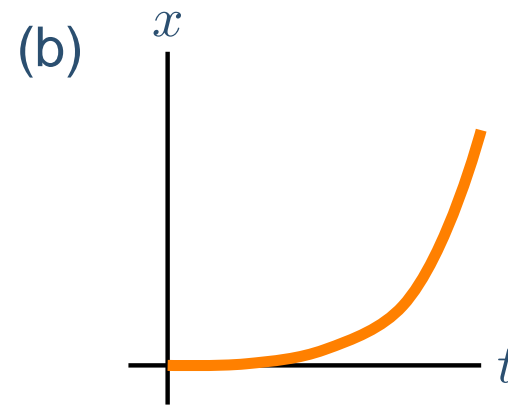
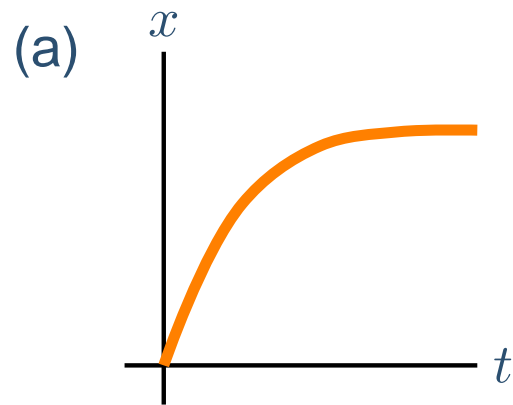
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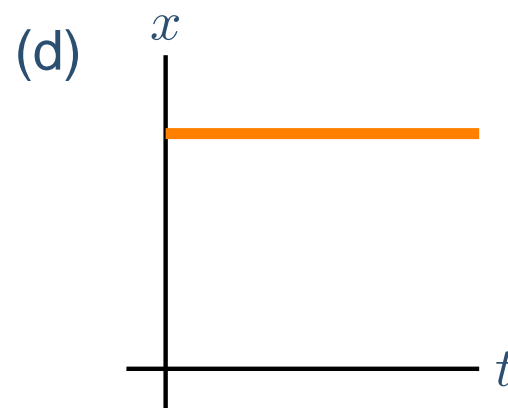
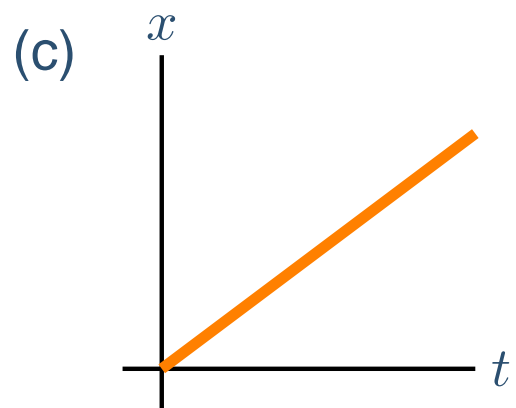
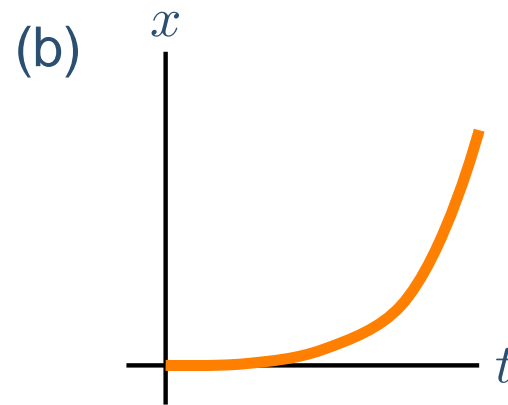
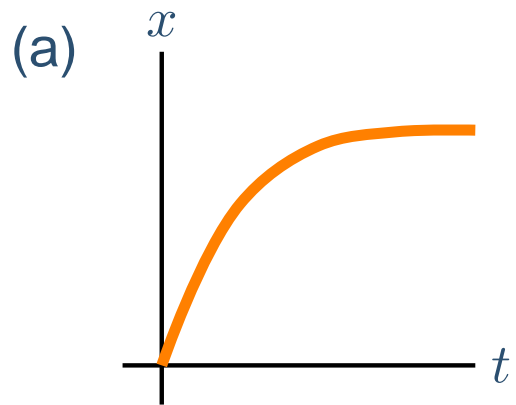
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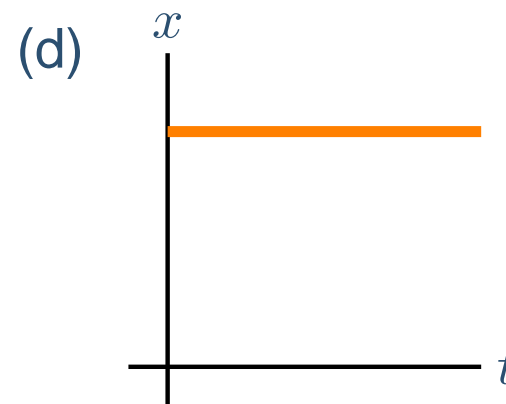
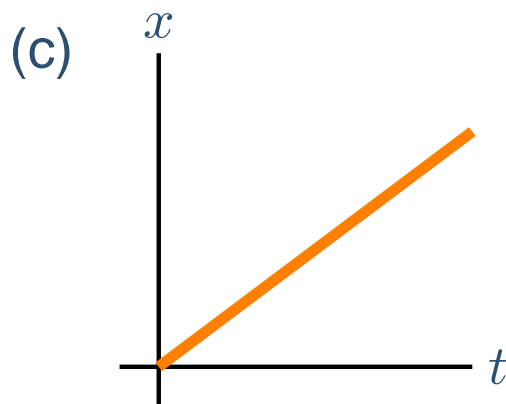
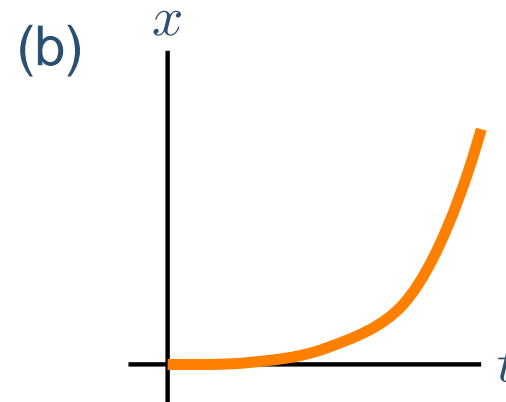
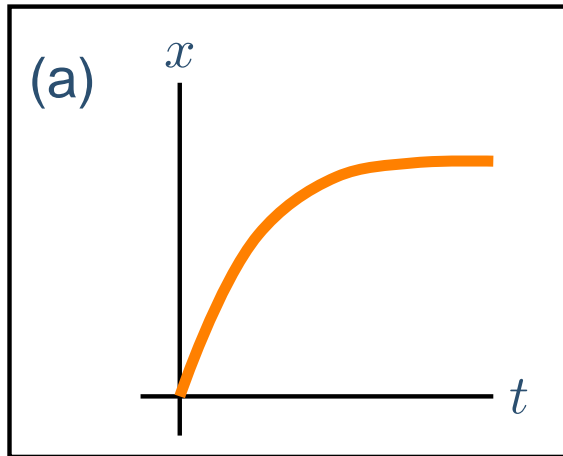
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(e) None of the above

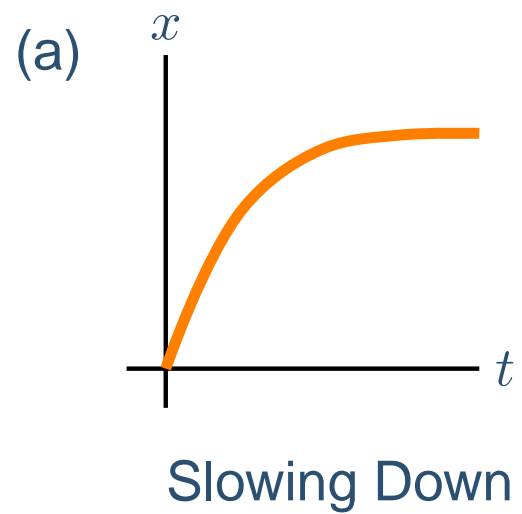
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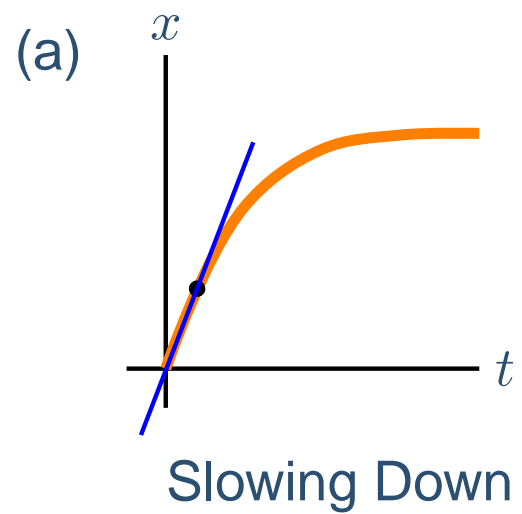


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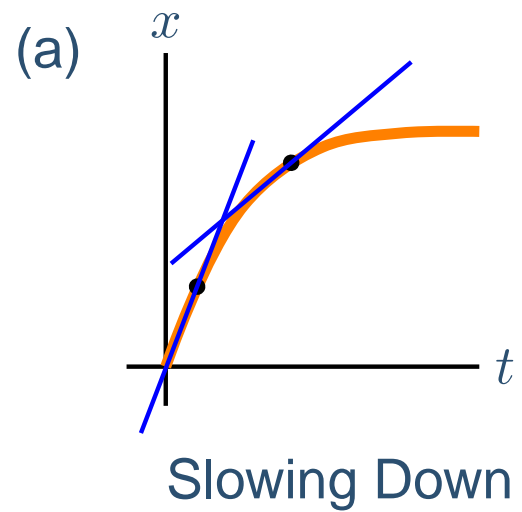
Velocity Followup



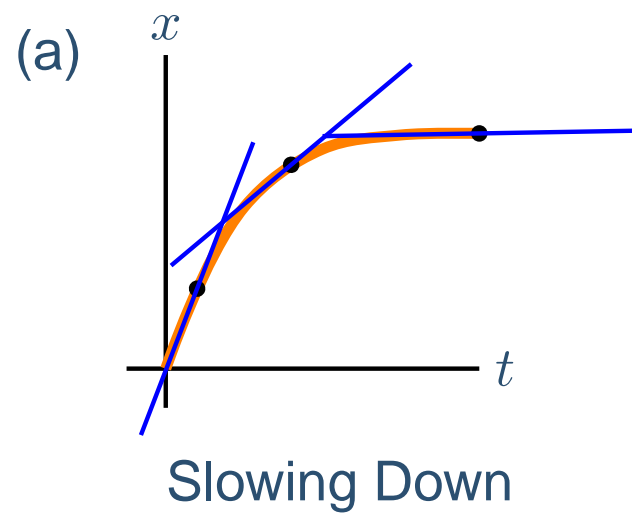
Velocity Followup



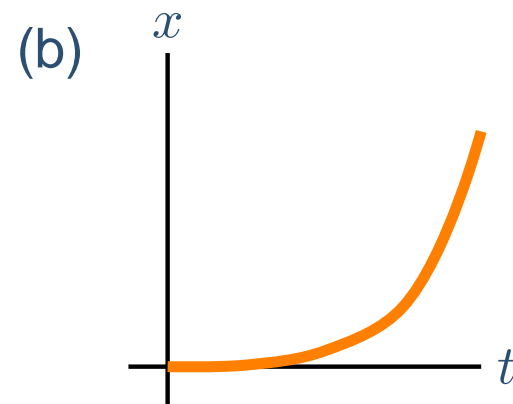
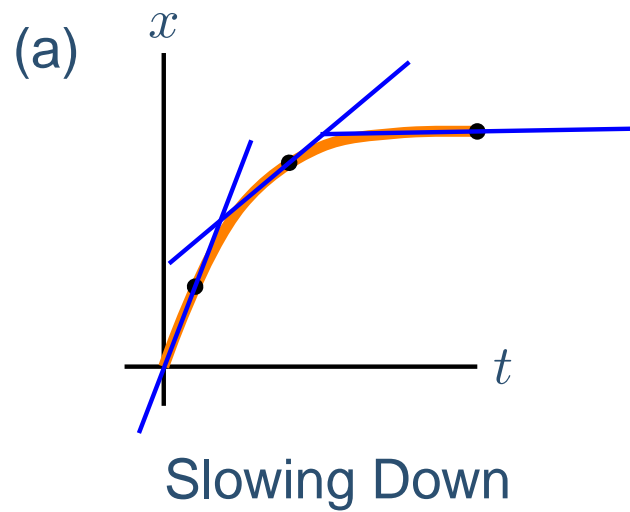
Velocity Followup



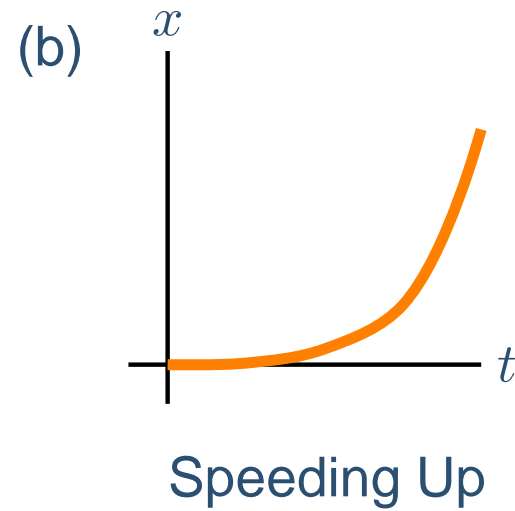
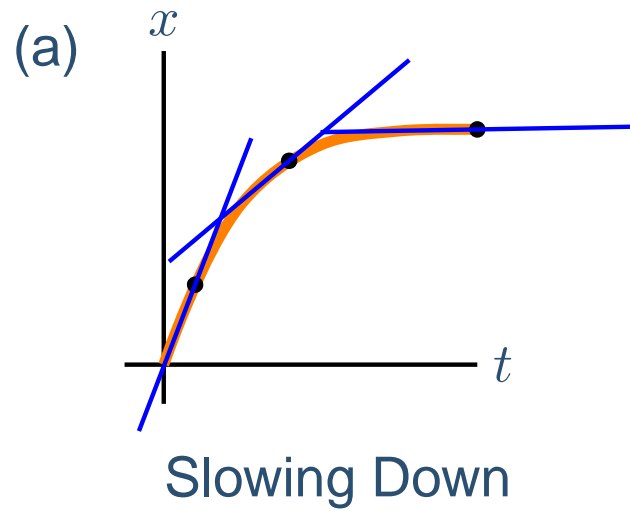
Velocity Followup



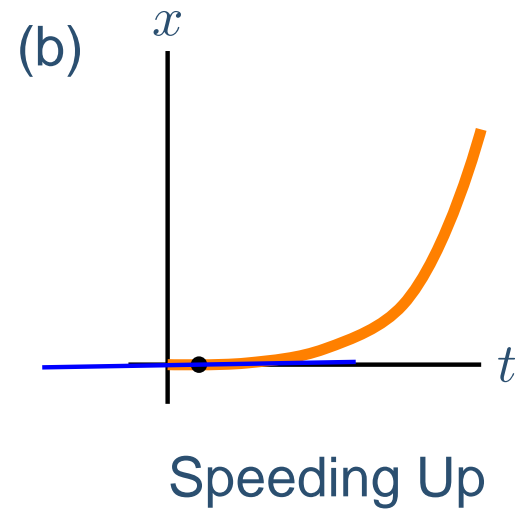
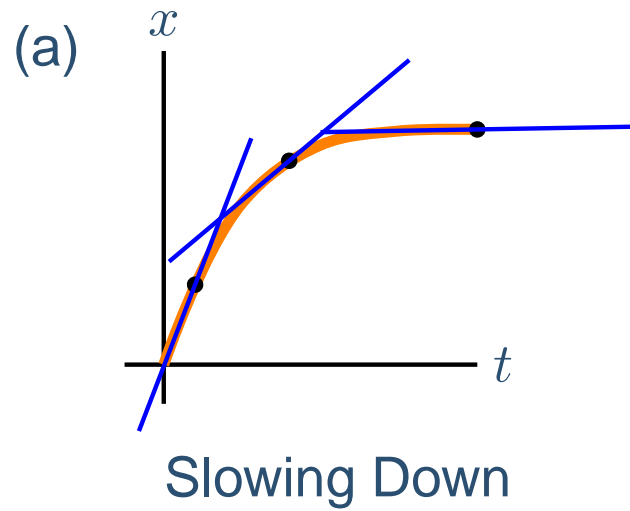
Velocity Followup



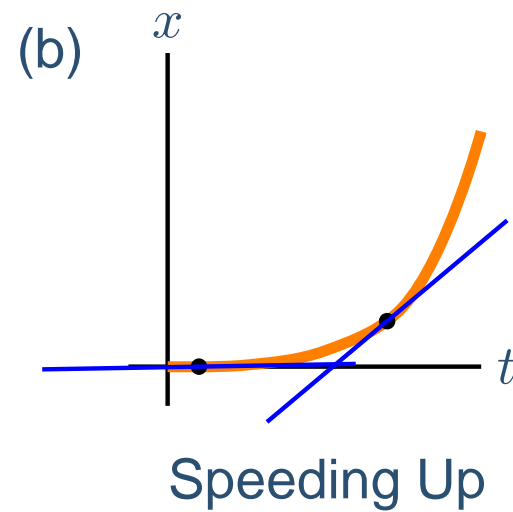
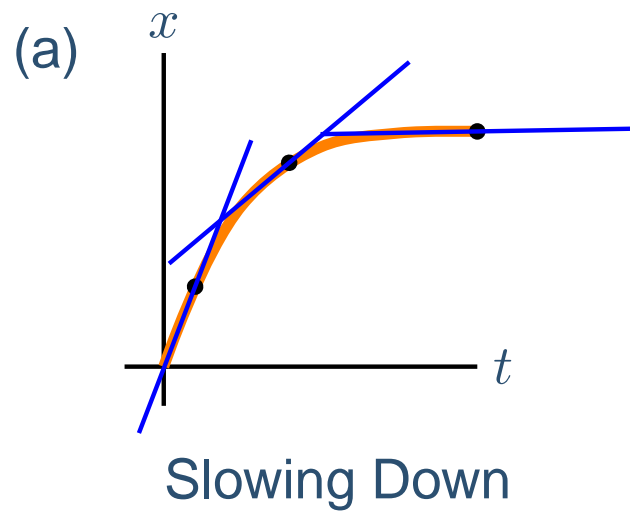
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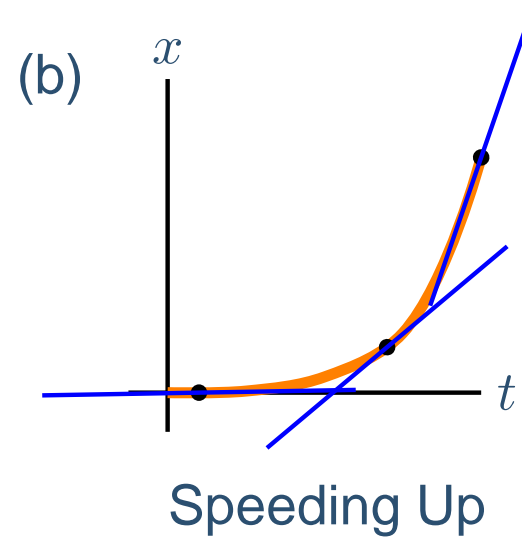
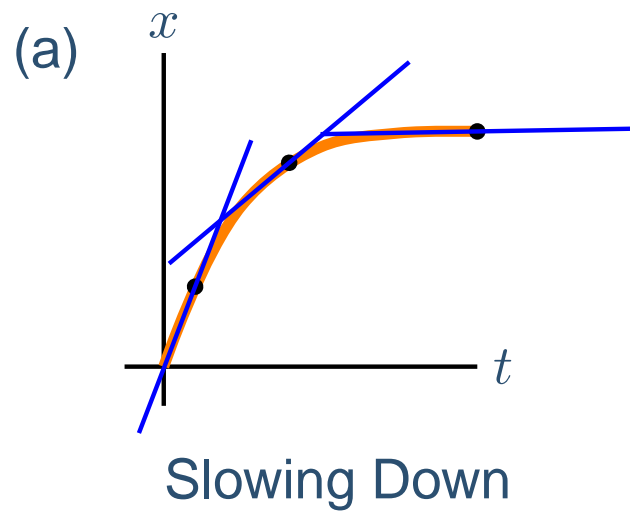
Velocity Followup



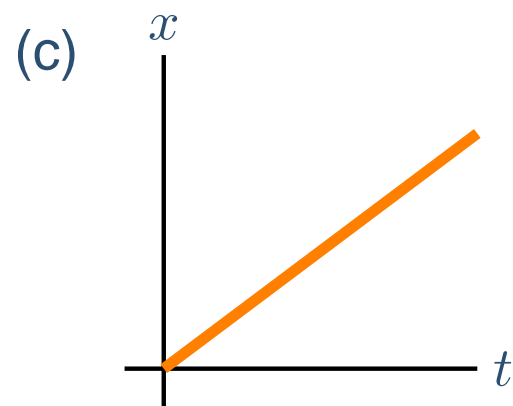
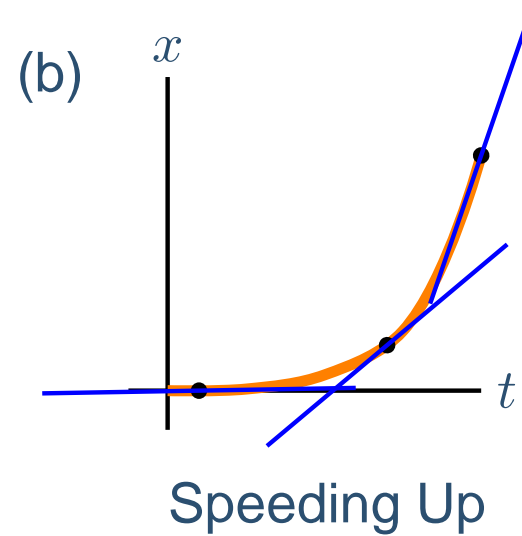
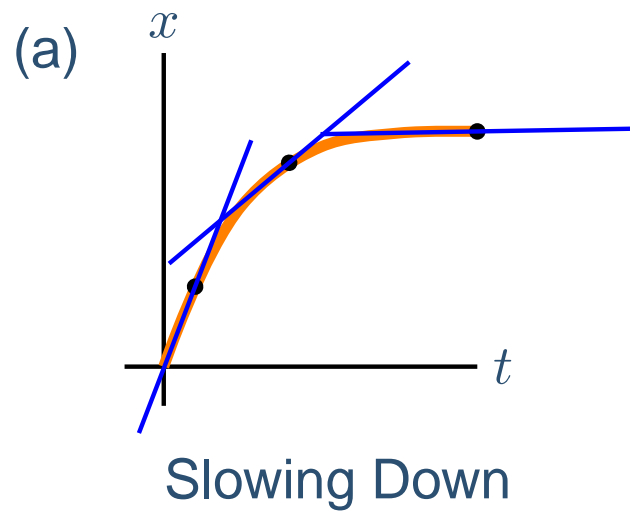
Velocity Followup



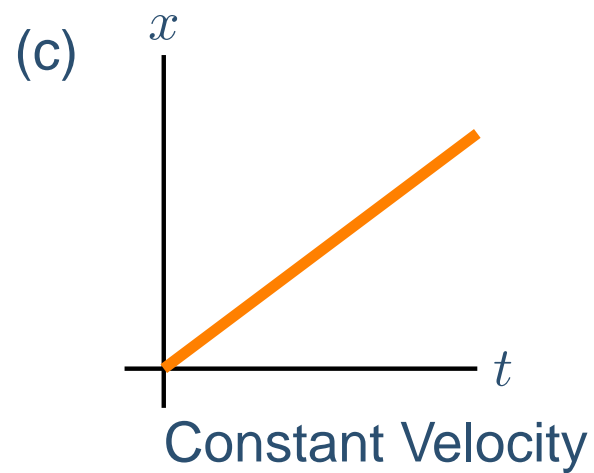
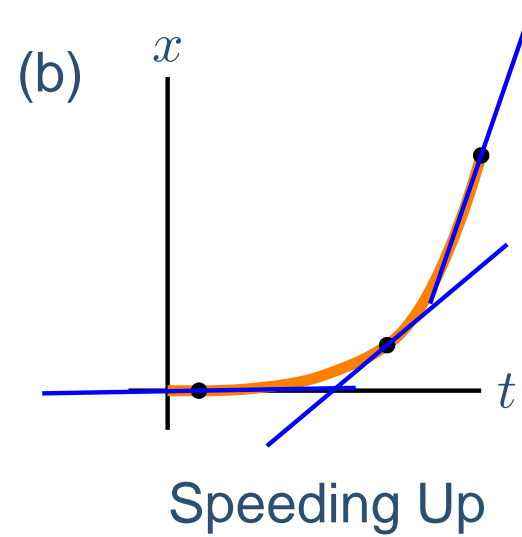
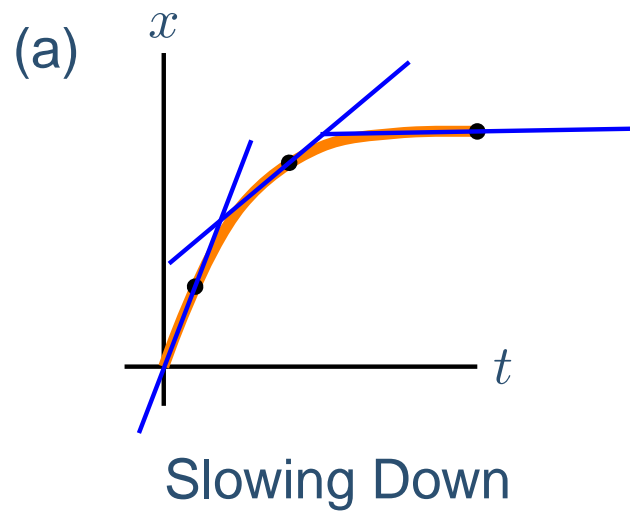
Velocity Followup



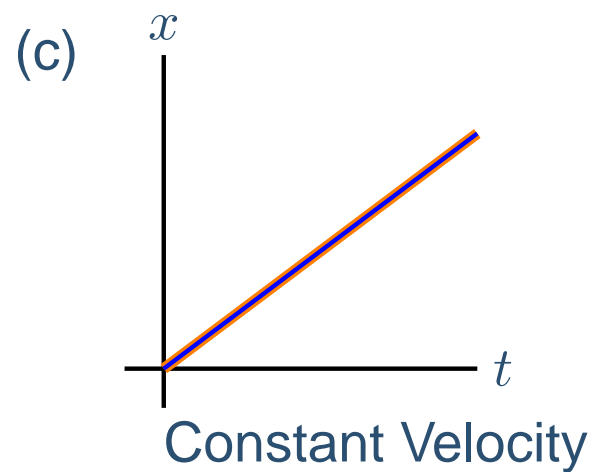
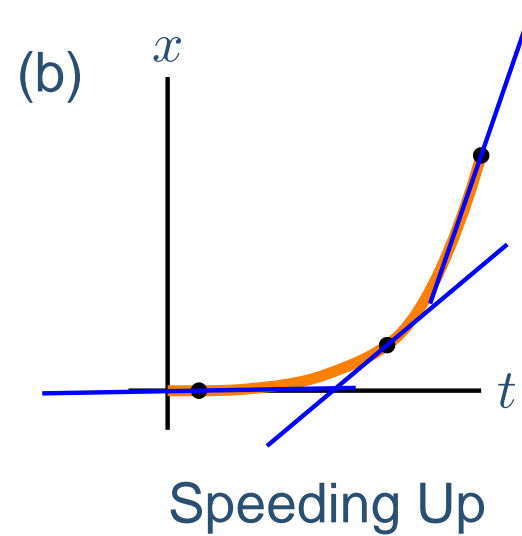
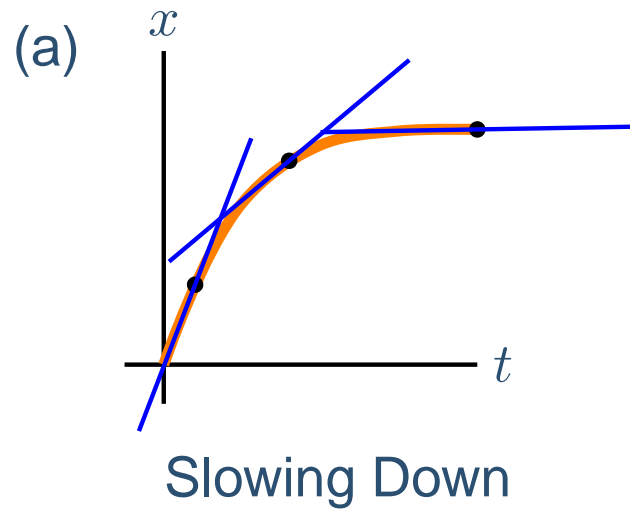
Velocity Followup



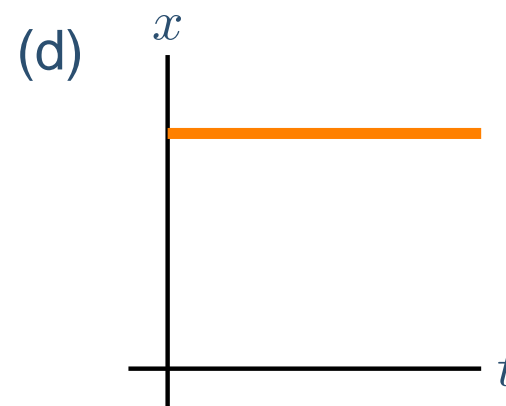
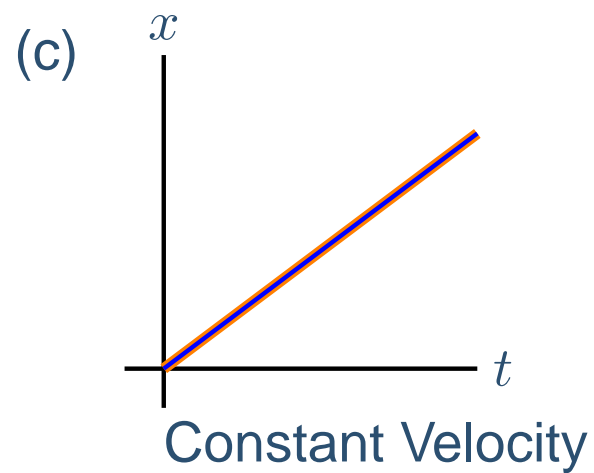
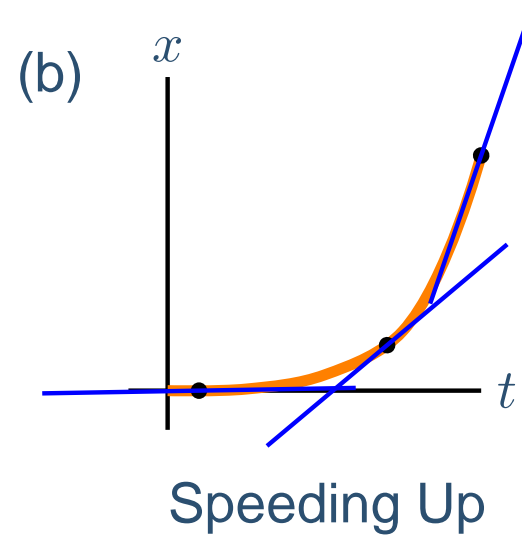
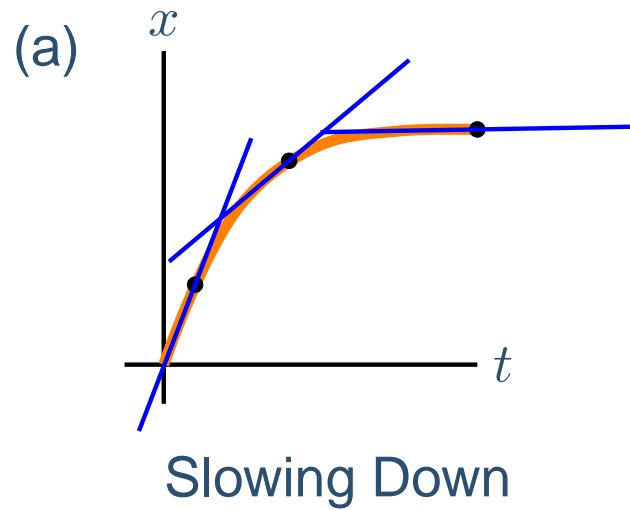
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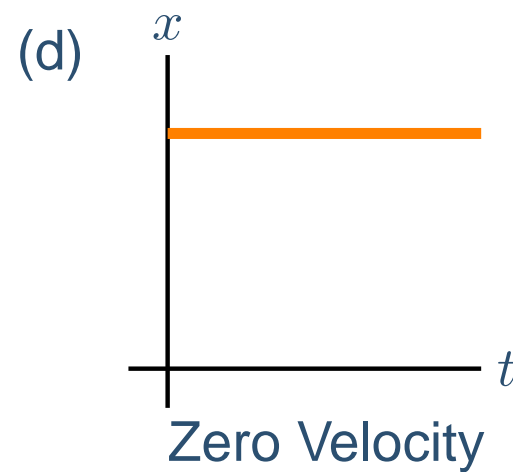
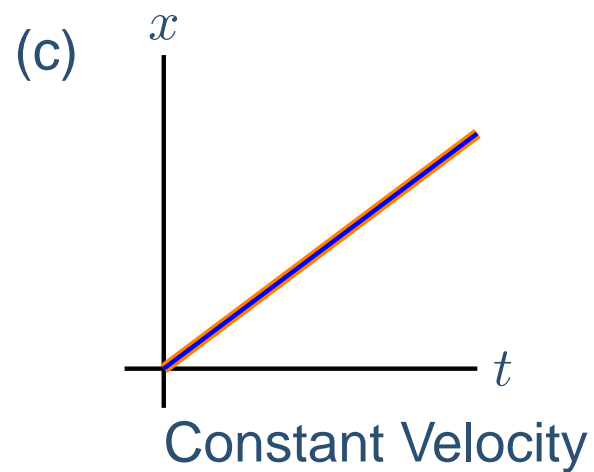
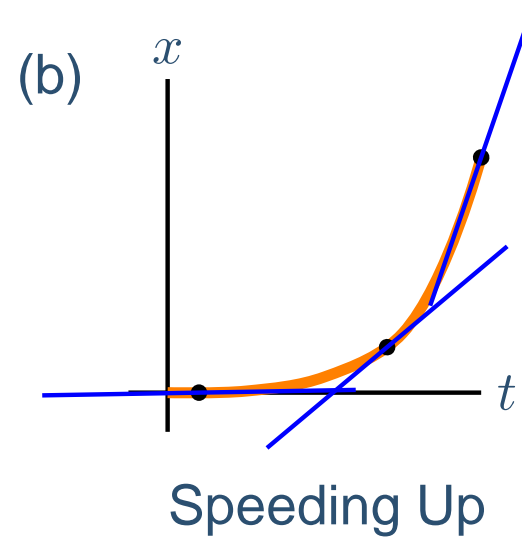
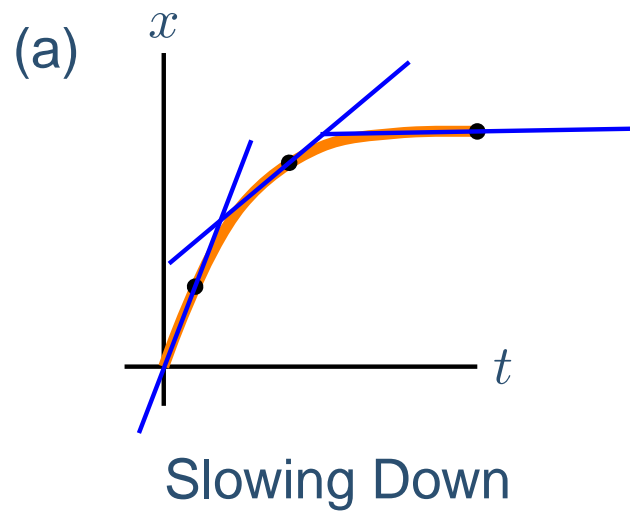
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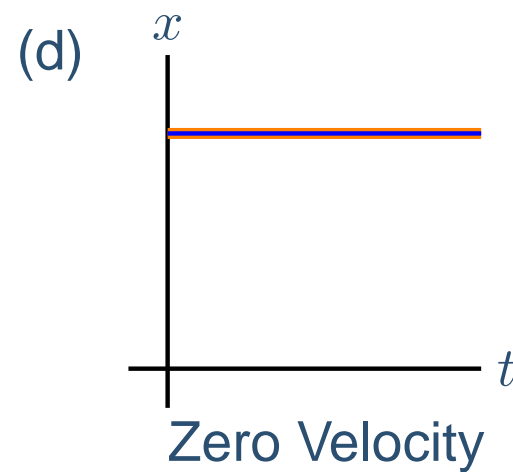
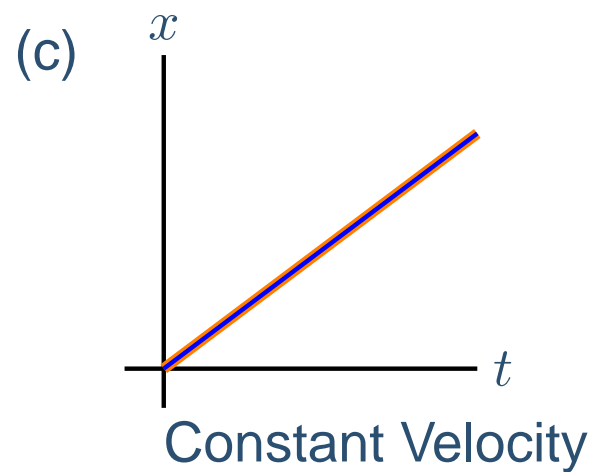
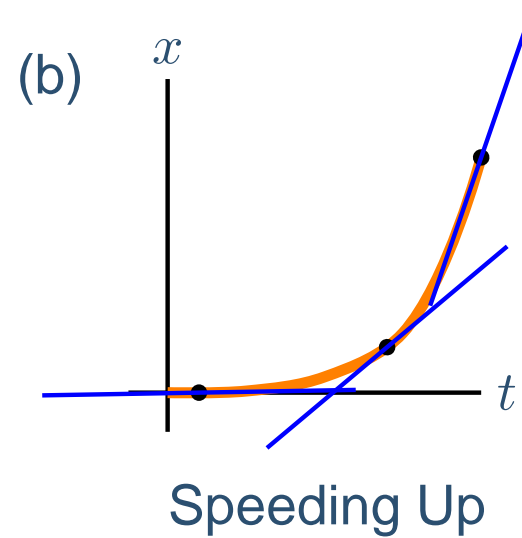
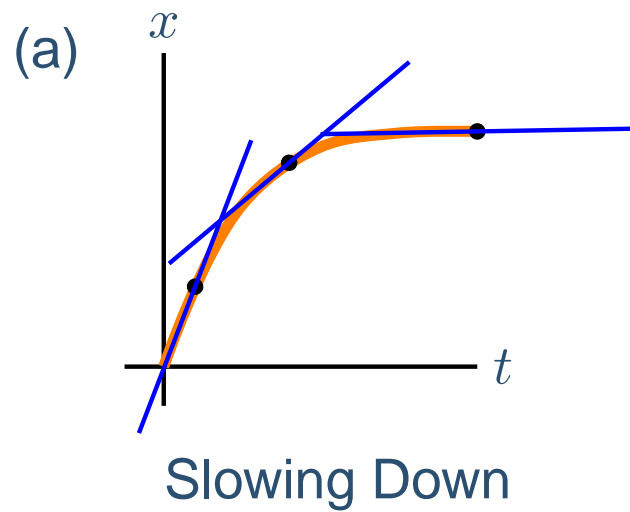
Velocity Followup



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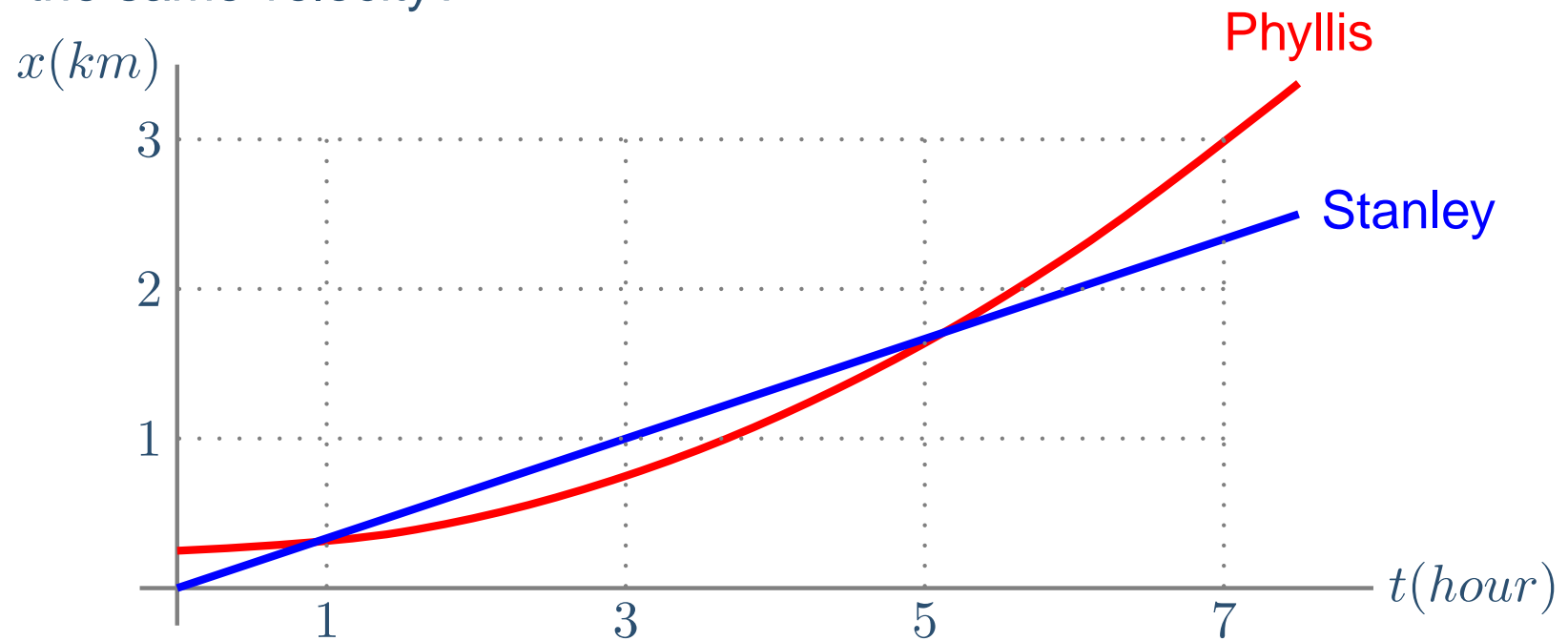


Velocity Followup



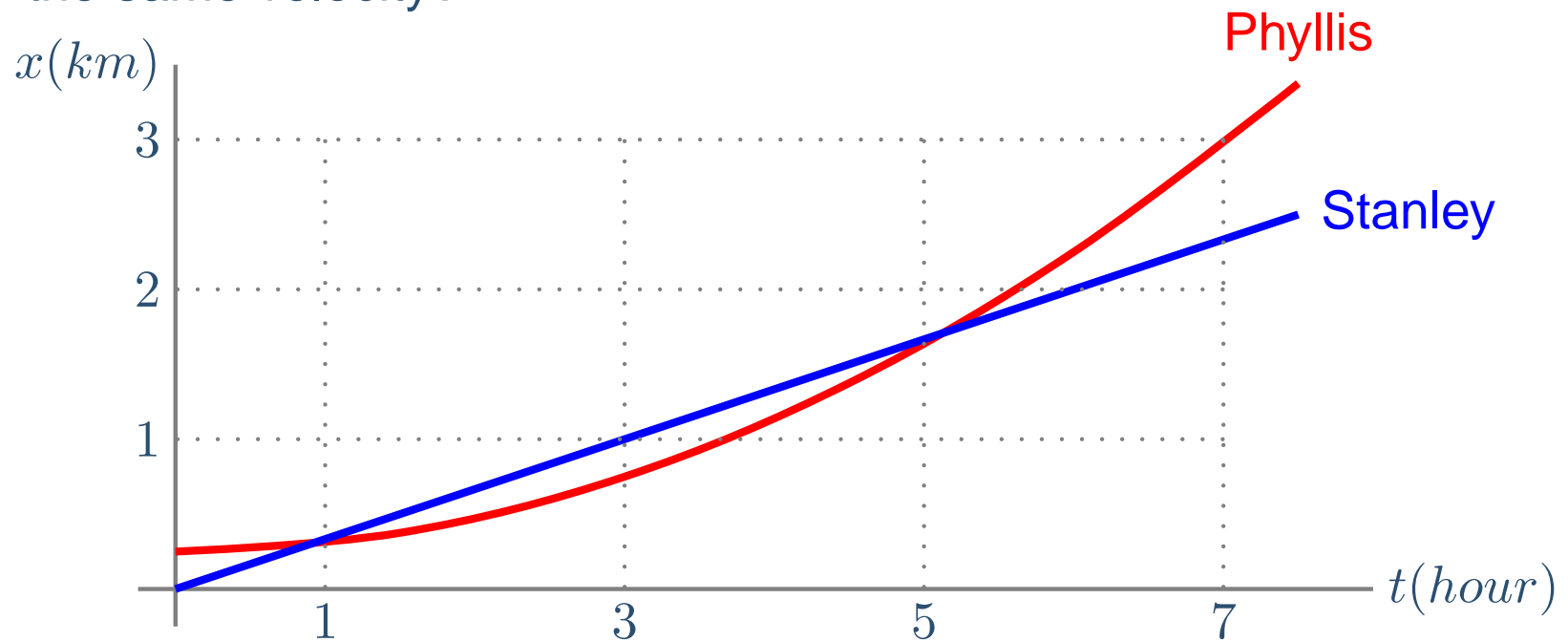
Velocity Exercise II

The position-versus-time graphs for two people, Phyllis and Stanley, are shown below. At what time or times do they have the same velocity?



Velocity Exercise II

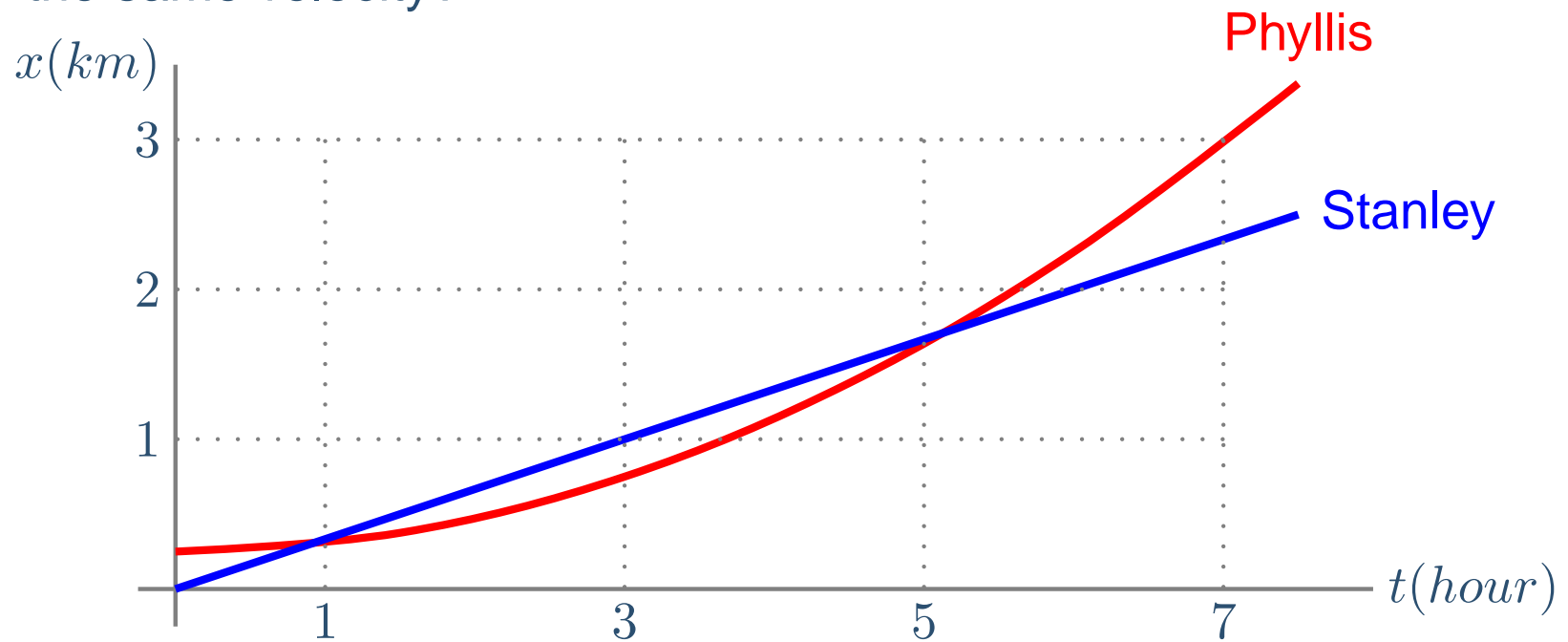
The position-versus-time graphs for two people, Phyllis and Stanley, are shown below. At what time or times do they have the same velocity?



(a) 1 h

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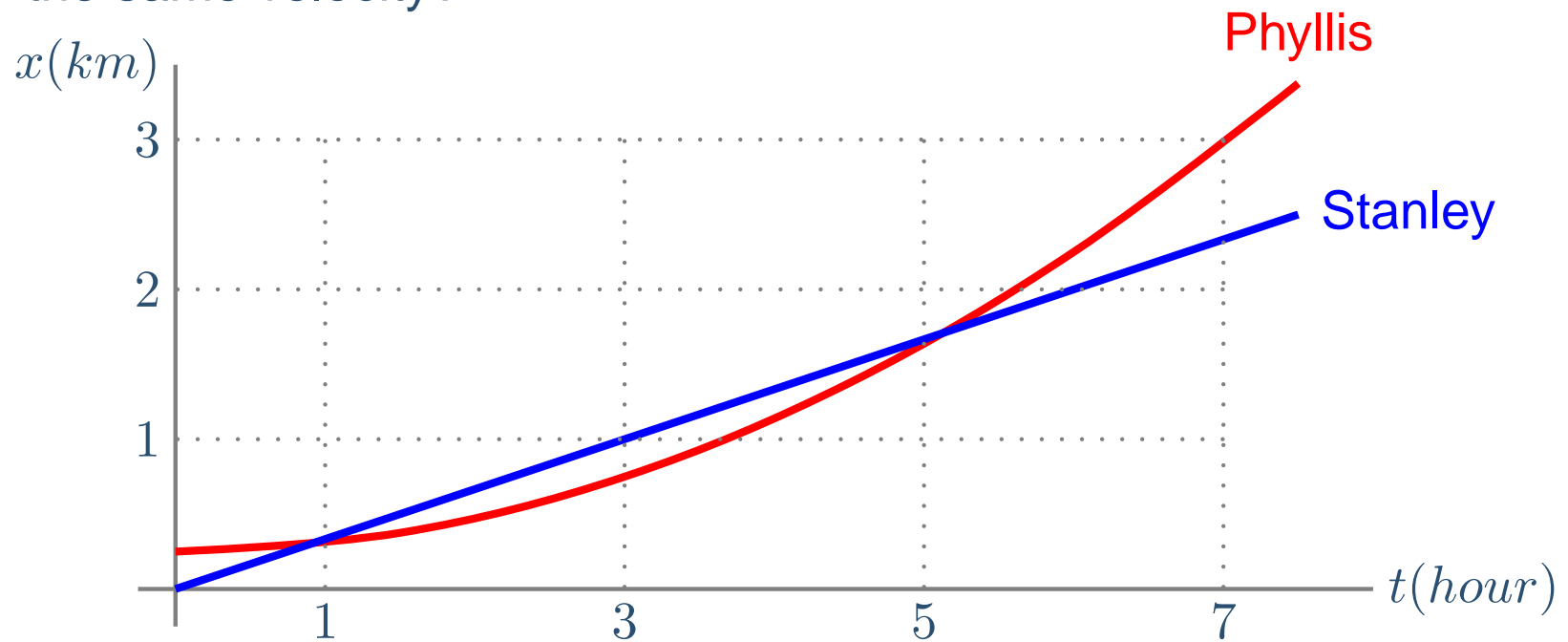


(a) 1 h

(b) 3 h

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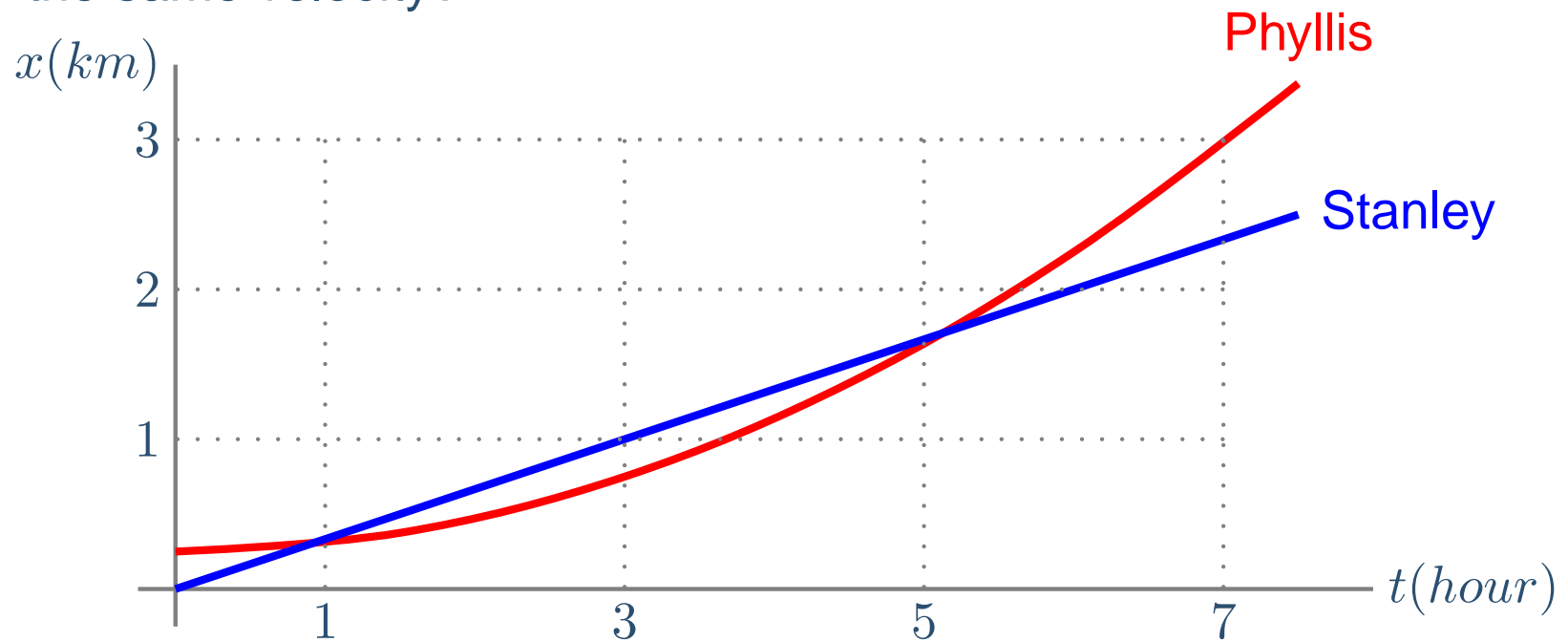
(a) 1 h

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(c) 5 h

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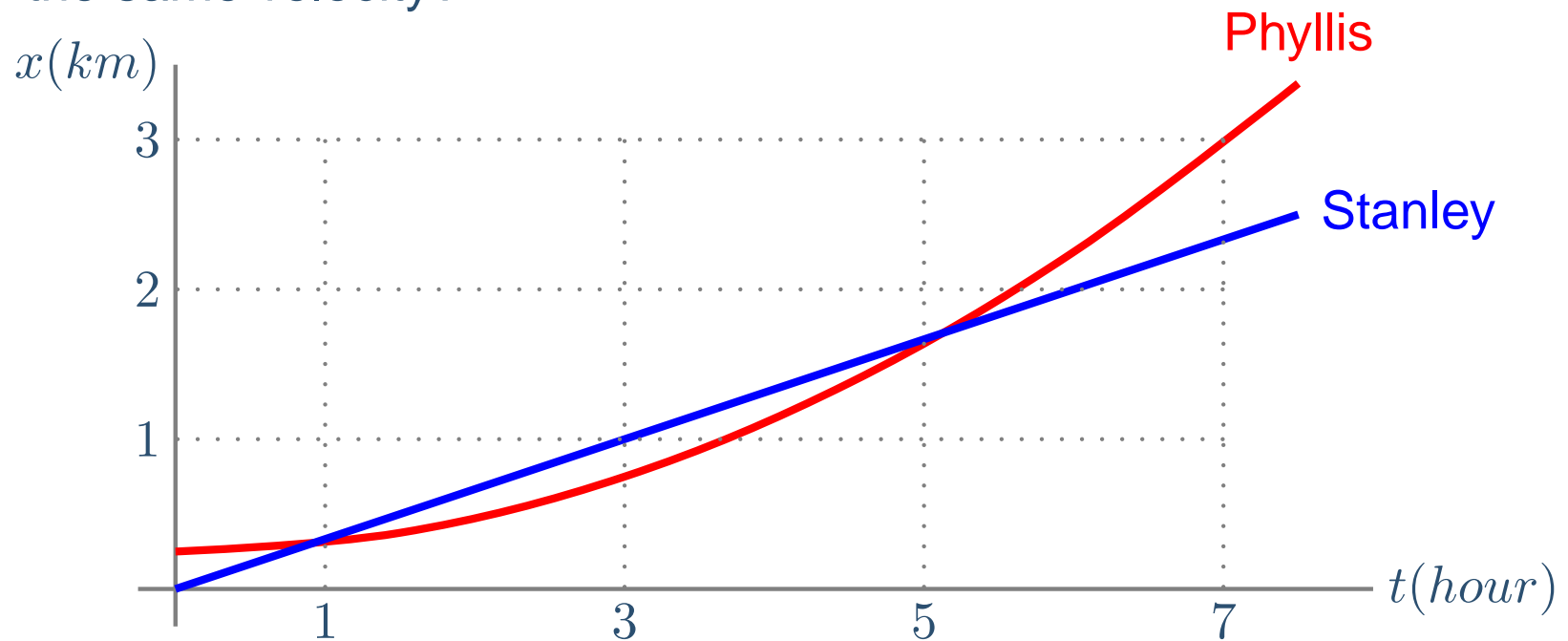
(b) 3 h

(c) 5 h

(d) Both 1 h
and 5 h

Velocity Exercise II

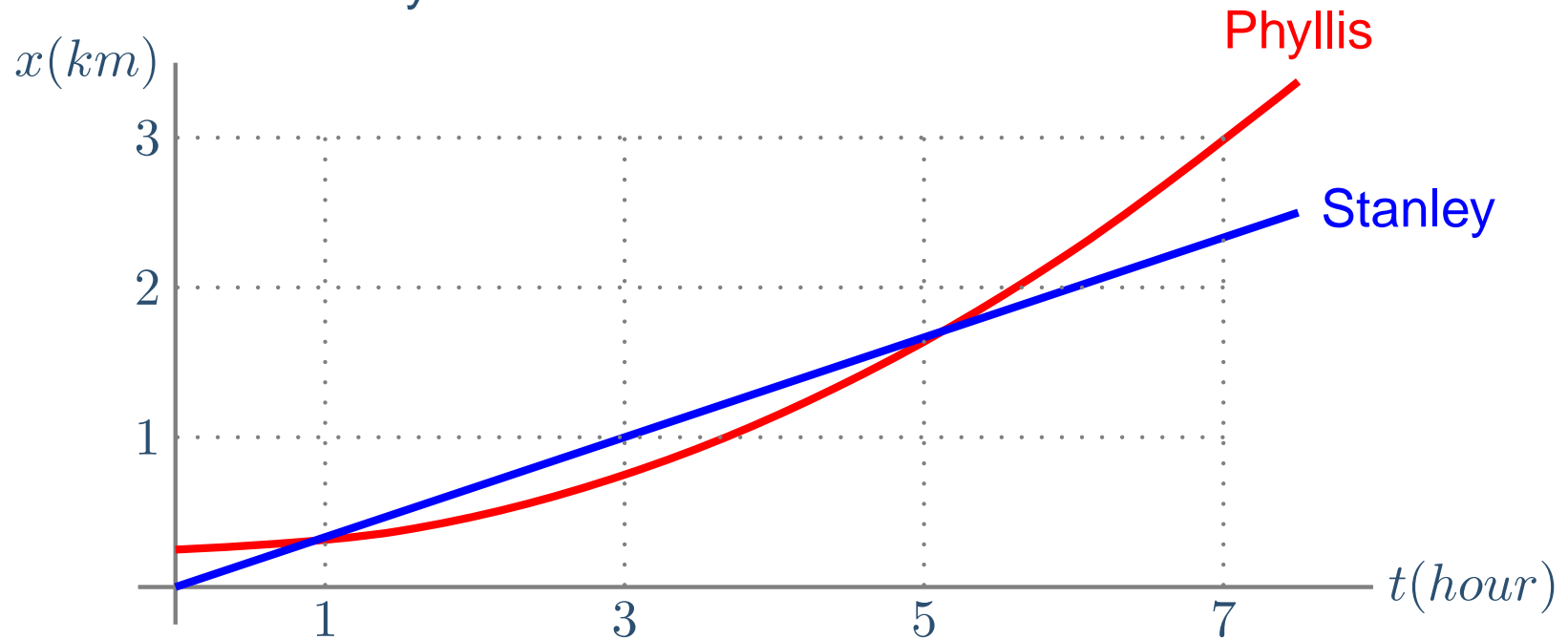
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- (a) 1 h (b) 3 h (c) 5 h (d) Both 1 h and 5 h (e) None are Correct

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(b) 3 h

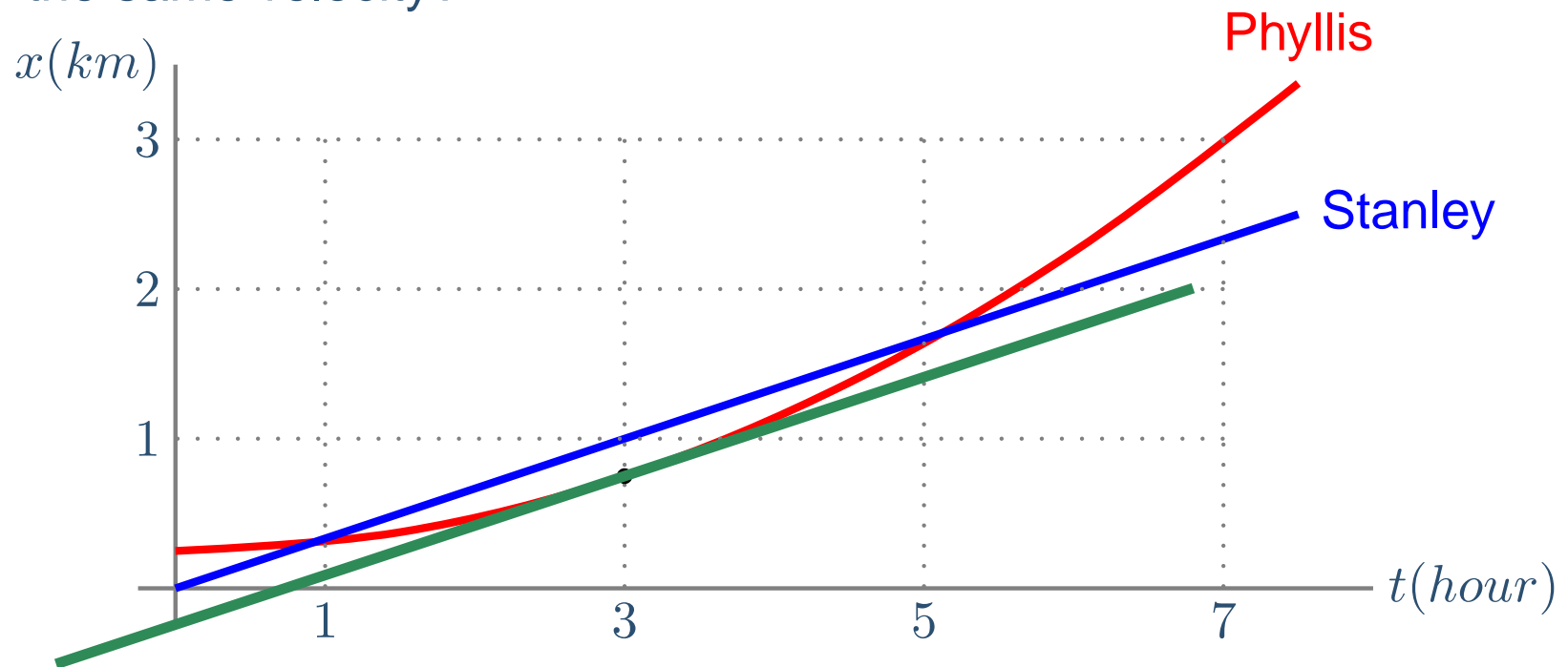
(c) 5 h

(d) Both 1 h
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(e) None are
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Correct

Acceleration

Acceleration, a_x - rate at which *velocity* changes.

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Unit: $\frac{m/s}{s}$

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Unit: $\frac{m/s}{s} = m/s^2$

Example: A rabbit accelerates from rest to $2.2 m/s$ in $0.5 s$. A turtle accelerates from rest to $2.2 m/s$ in $1 min$. Find average acceleration of both.

Acceleration

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$$a_r = \frac{2.2 \text{ m/s}}{0.5 \text{ s}} = 4.4 \text{ m/s}^2 \quad a_t = \frac{2.2 \text{ m/s}}{60 \text{ s}} = 0.0367 \text{ m/s}^2$$

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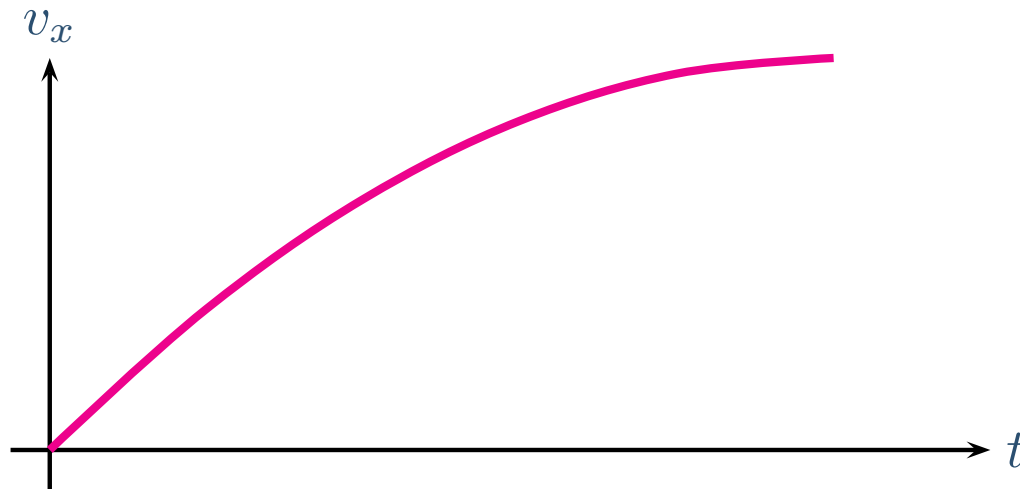


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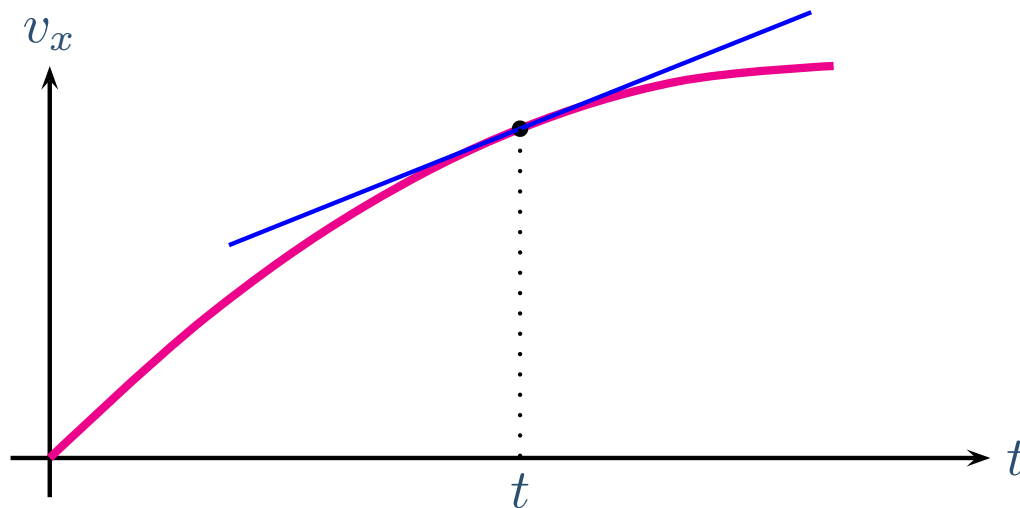


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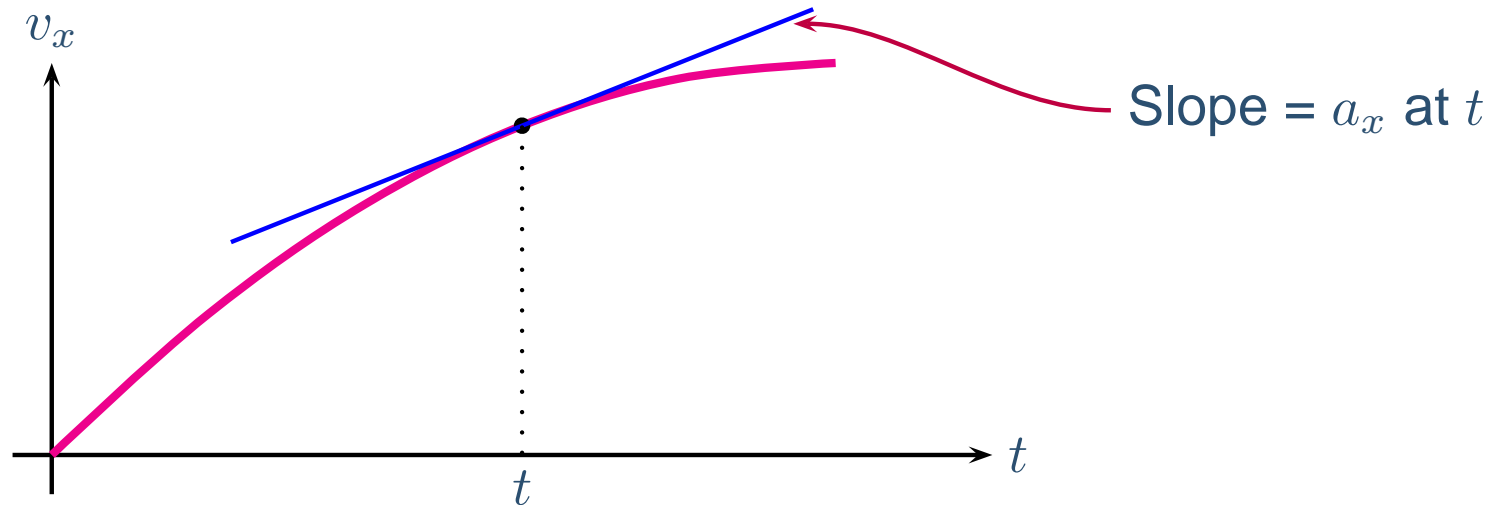


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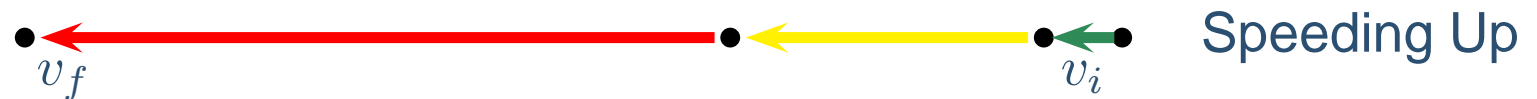


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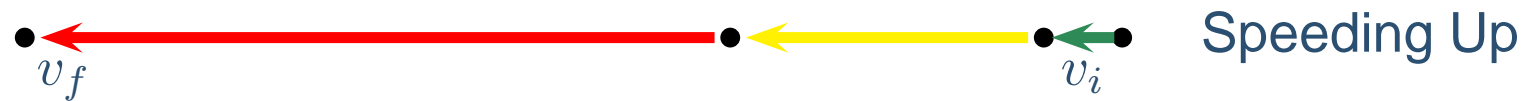


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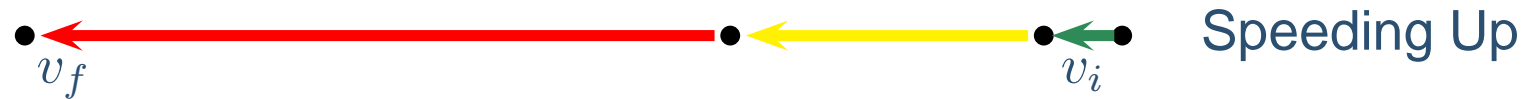
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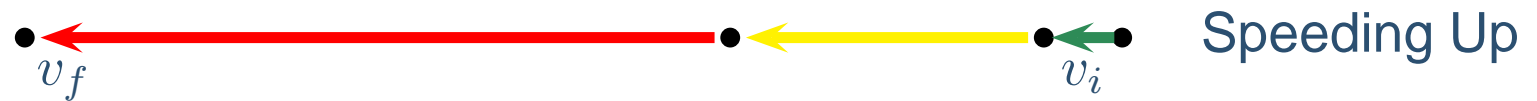
- Slowing Down

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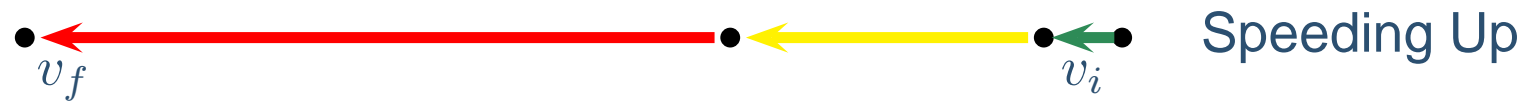


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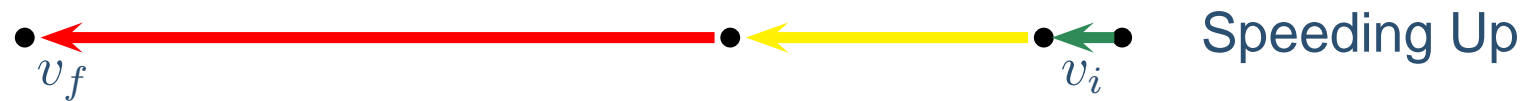


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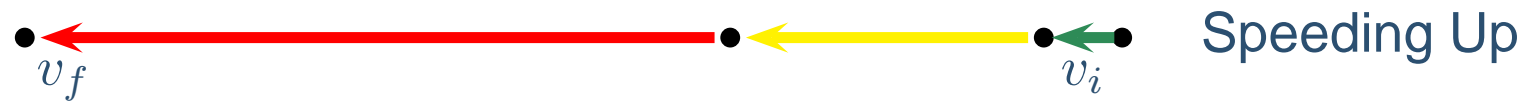


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Velocity is getting more negative $\Rightarrow a_x < 0$



Velocity is getting more positive $\Rightarrow a_x > 0$

Acceleration versus Deceleration II

In Summary:

When a_x and v_x have the same sign, speed increases.

When a_x and v_x have the opposite sign, speed decreases.