Lecture Notes

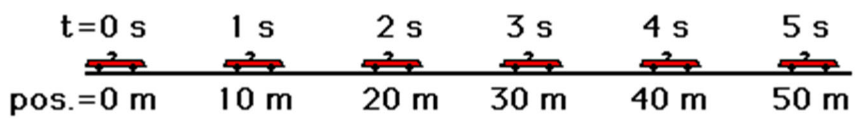
(Position & Velocity Time Graphs)

Position-Time Graphs:

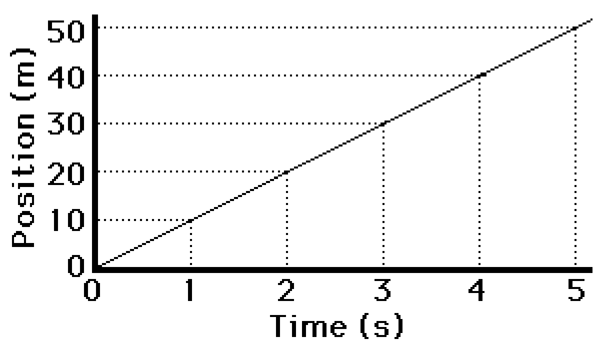
- a position-time graph will allow you to demonstrate motion in one dimension

- the specific features of the motion of objects are demonstrated by the shape and the slope of the lines on a position-time graph

- to begin, consider a car moving with a constant, rightward (+) velocity of 10 m/s

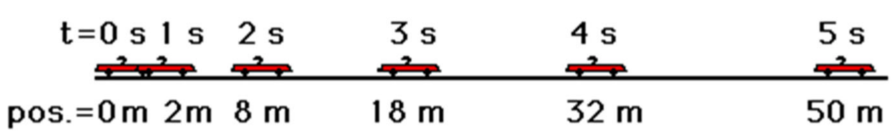


- if the position-time data for such a car were graphed, the resulting graph would look like the graph at the right

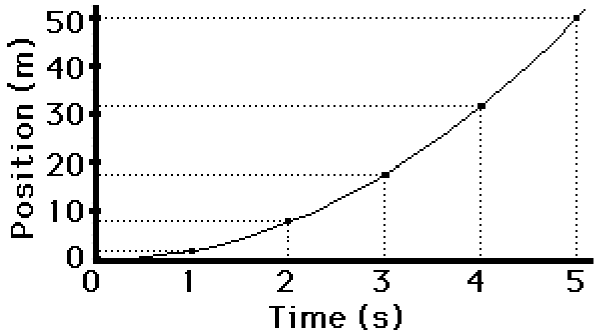


- note that a motion with constant, positive velocity results in a line of constant and positive slope when plotted as a position-time graph

- now consider a car moving with a changing, rightward (+) velocity – that is, a car that is moving rightward and speeding up or accelerating

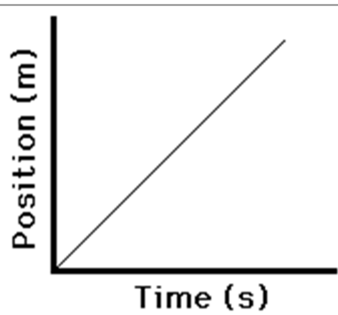
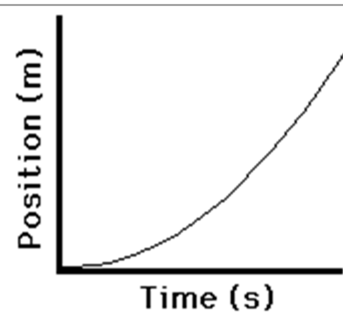


- if the position-time data for such a car were graphed, the resulting graph would look like the graph at the right



- note that a motion with changing, positive velocity results in a line of changing and positive slope when plotted as a position-time graph

- the position vs. time graphs for the two types of motion – constant velocity and changing velocity (acceleration) – are depicted as follows:

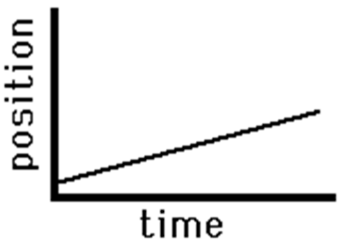
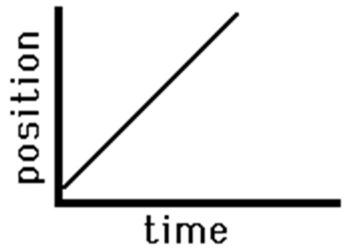
Positive Velocity (Constant Velocity)	Positive Velocity (Acceleration)
	

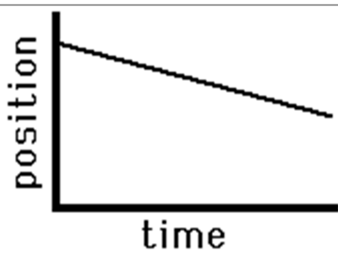
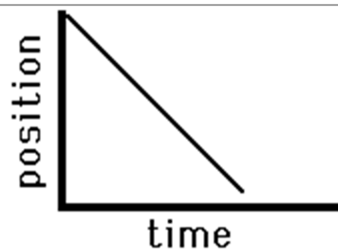
- the slope of the line on a position-time graph reveals useful information about the velocity of the object

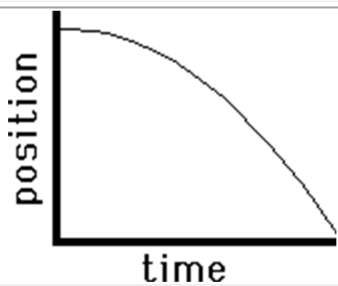
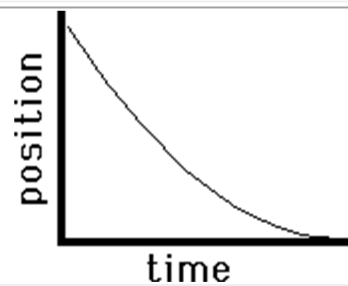
- if the velocity is constant, then the slope is constant (i.e., a straight line)

- if the velocity is changing, then the slope is changing (i.e., a curved line)

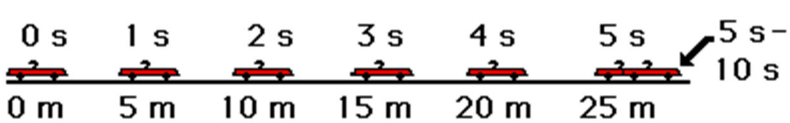
- if the velocity is positive, then the slope is positive (i.e., moving upwards and to the right)

Slow, Rightward (+) Constant Velocity	Fast, Rightward (+) Constant Velocity
	

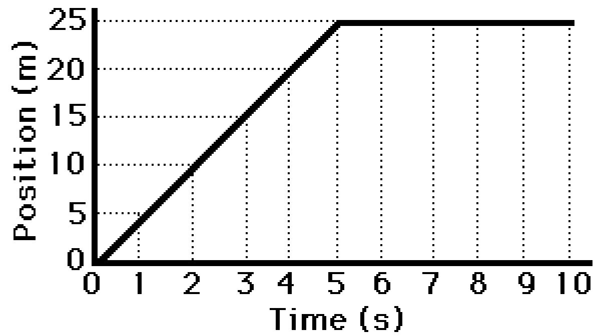
Slow, Leftward (–) Constant Velocity	Fast, Leftward (–) Constant Velocity
	

Leftward (–) Velocity; Slow to Fast	Leftward (–) Velocity; Fast to Slow
	

- consider a car moving with a constant velocity of +5 m/s for 5 seconds, stopping abruptly, and then remaining at rest (***v*** = 0 m/s) for 5 seconds



- for the first five seconds, the line on the graph goes up 5 meters along the vertical (position) axis for every 1 second along the horizontal (time) axis; that is, the line on the position vs. time graph has a slope of +5 meters/1 second for the first five seconds



- during the last 5 seconds (5 to 10 seconds), the line goes up 0 meters

- the slope of the line on a position-time graph is equal to the velocity of the object

- if the object is moving with a velocity of +4 m/s, then the slope of the line will be +4 m/s; if the object is moving with a velocity of -8 m/s, then the slope of the line will be -8 m/s

Calculating the Slope:

- the slope of a line is found by dividing the amount of rise of the line between any two points by the amount of run of the line between the same two points

Slope: $m = \frac{rise}{run} = \frac{\Delta y}{\Delta x} = \frac{y_f - y_i}{x_f - x_i}$

Uniform Motion Equation:

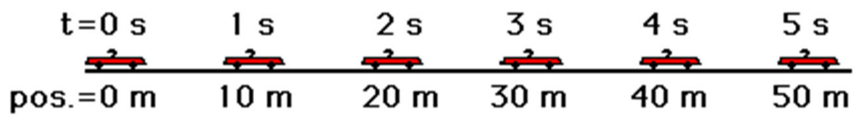
- if we rearrange the average velocity equation $\bar{\boldsymbol{v}} = \frac{\Delta \boldsymbol{d}}{\Delta t}$, we can solve for the position of an object with constant velocity

- we can rewrite the equation as: $\boldsymbol{d}_f = \boldsymbol{d}_i + \boldsymbol{v}t$

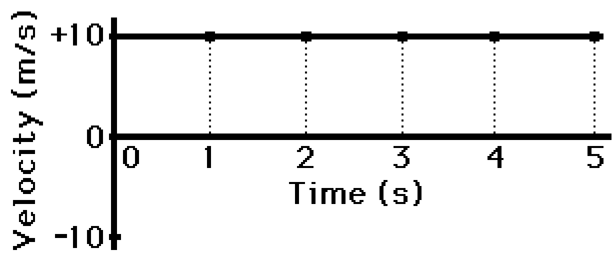
d_i = initial position
v = constant velocity
t = time
d_f = position at that time

Velocity-Time Graphs:

- consider a car moving with a constant, rightward (+) velocity of +10 m/s.; in the last lecture, we learned that a car moving with a constant velocity is a car moving with zero acceleration



- if the velocity-time data for such a car were graphed, the resulting graph would look like the graph at the right

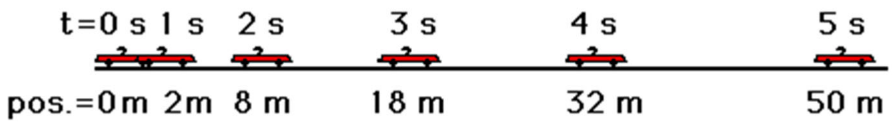


- note that a motion with constant, positive velocity results in a line of zero slope

- a horizontal line has zero slope when plotted as a velocity-time graph; furthermore, only positive velocity values are plotted, corresponding to a motion with positive velocity

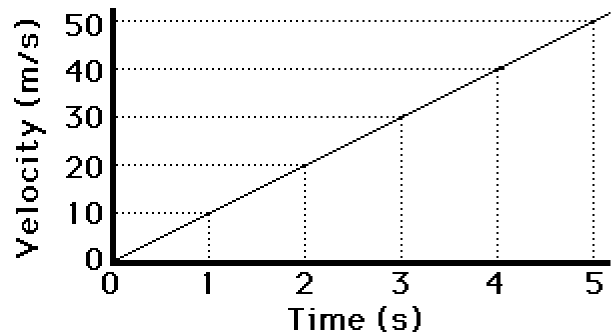
- now consider a car moving with a rightward (+), changing velocity – that is, a car that is moving rightward and speeding up or accelerating

- since the car is moving in the positive direction and speeding up, it is said to have a positive acceleration



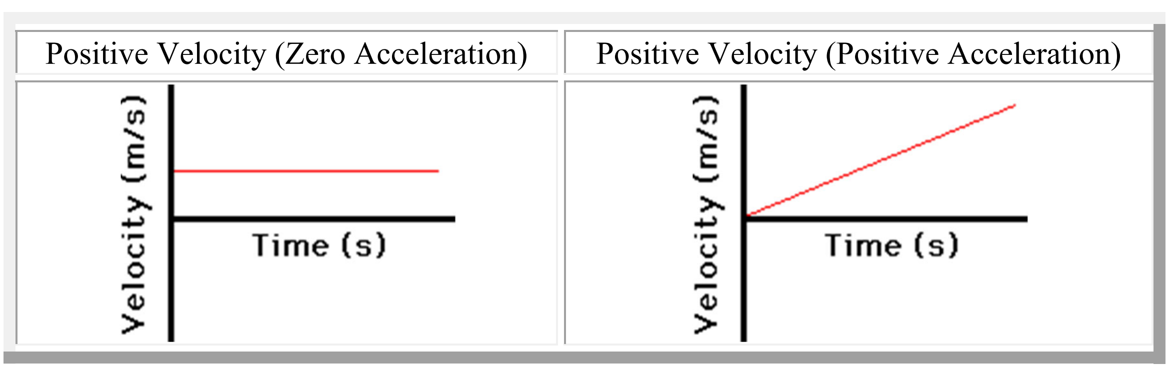
- if the velocity-time data for such a car were graphed, the resulting graph would look like the graph below

- note that a motion with changing, positive velocity results in a diagonal line when plotted as a velocity-time graph



- the slope of this line is positive, corresponding to the positive acceleration; in addition, only positive velocity values are plotted, corresponding to a motion with positive velocity

- the velocity-time graphs for the two types of motion – constant velocity and changing velocity (acceleration) – can be summarized as follows:



- the slope of the line on a velocity-time graph reveals the acceleration of an object

- if the acceleration is zero, then the slope is zero (i.e., a horizontal line)

- if the acceleration is positive, then the slope is positive (i.e., an upward sloping line)

- if the acceleration is negative, then the slope is negative (i.e., a downward sloping line)

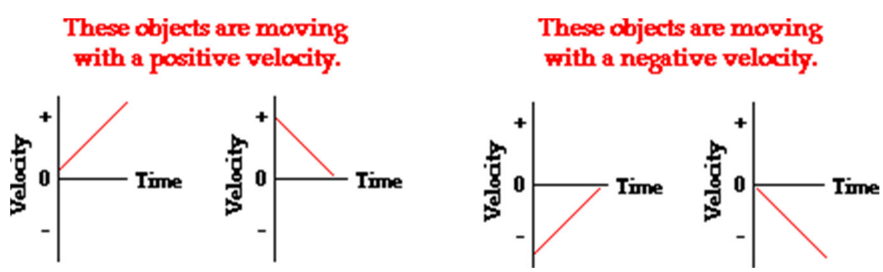
- the velocity is positive whenever the line lies in the positive region (positive y-values, i.e. above the x-axis) of the graph

- the velocity is negative whenever the line lies in the negative region (negative y-values, i.e. below the x-axis) of the graph

- if an object is moving in the positive direction, the line is located in the positive region of the velocity-time graph (regardless if it is sloping up or sloping down)

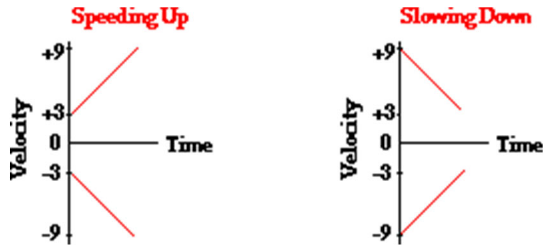
- if an object is moving in the negative direction if the line is located in the negative region of the velocity-time graph (regardless if it is sloping up or sloping down)

- if a line crosses the x-axis from the positive region to the negative region of the graph (or vice versa), then the object has changed directions



- if the line is moving away from the x-axis (the 0-velocity point), then the object is speeding up

- if the line is moving towards the x-axis, the object is slowing down


Speeding Up
Slowing Down
Velocity
Time
+9
+3
0
-3
-9