A Helpful Chart

Differentiate

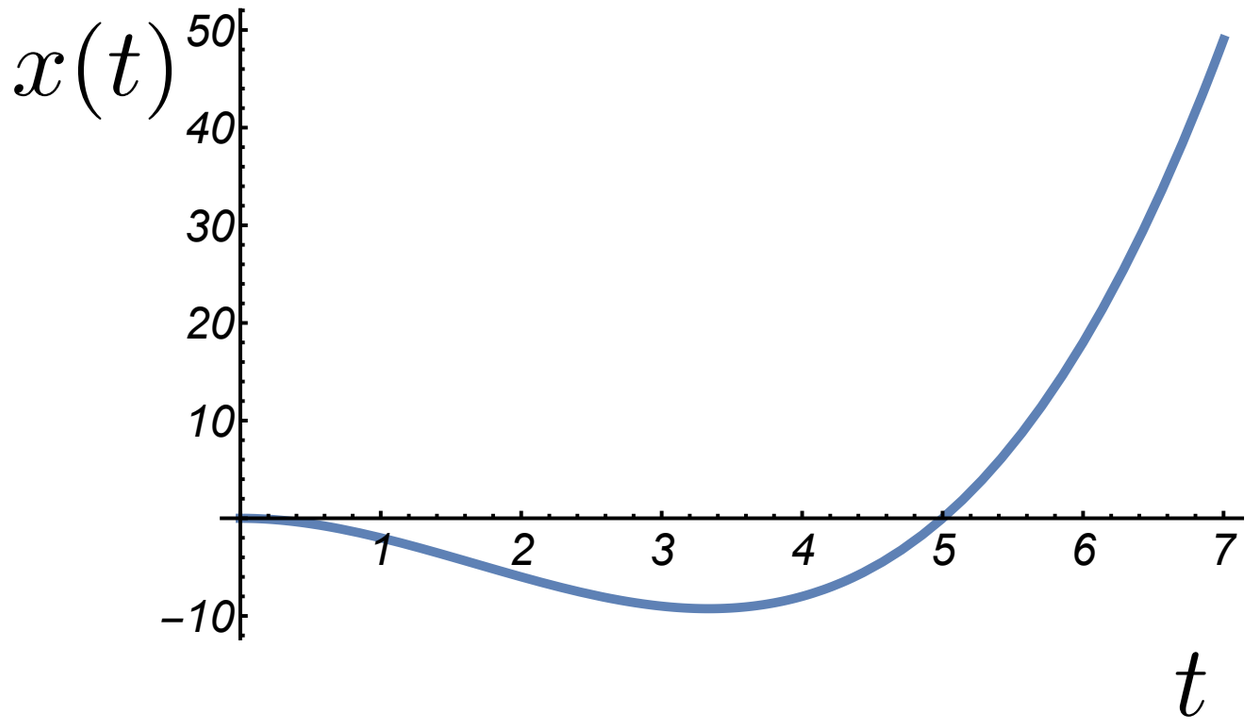
$$s \xrightarrow{} v \xrightarrow{} a$$

$$\xleftarrow{} \xleftarrow{}$$

Integrate

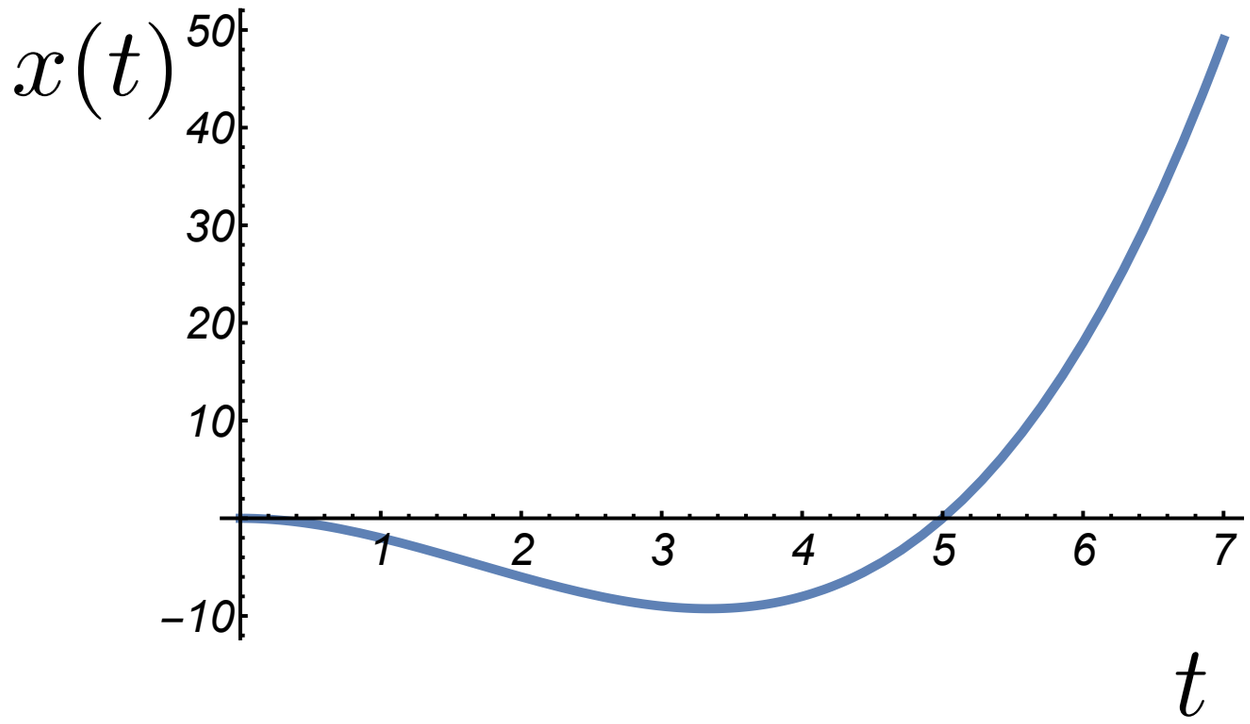
The Derivative

$$x(t) = \frac{1}{2}t^3 - \frac{5}{2}t^2$$

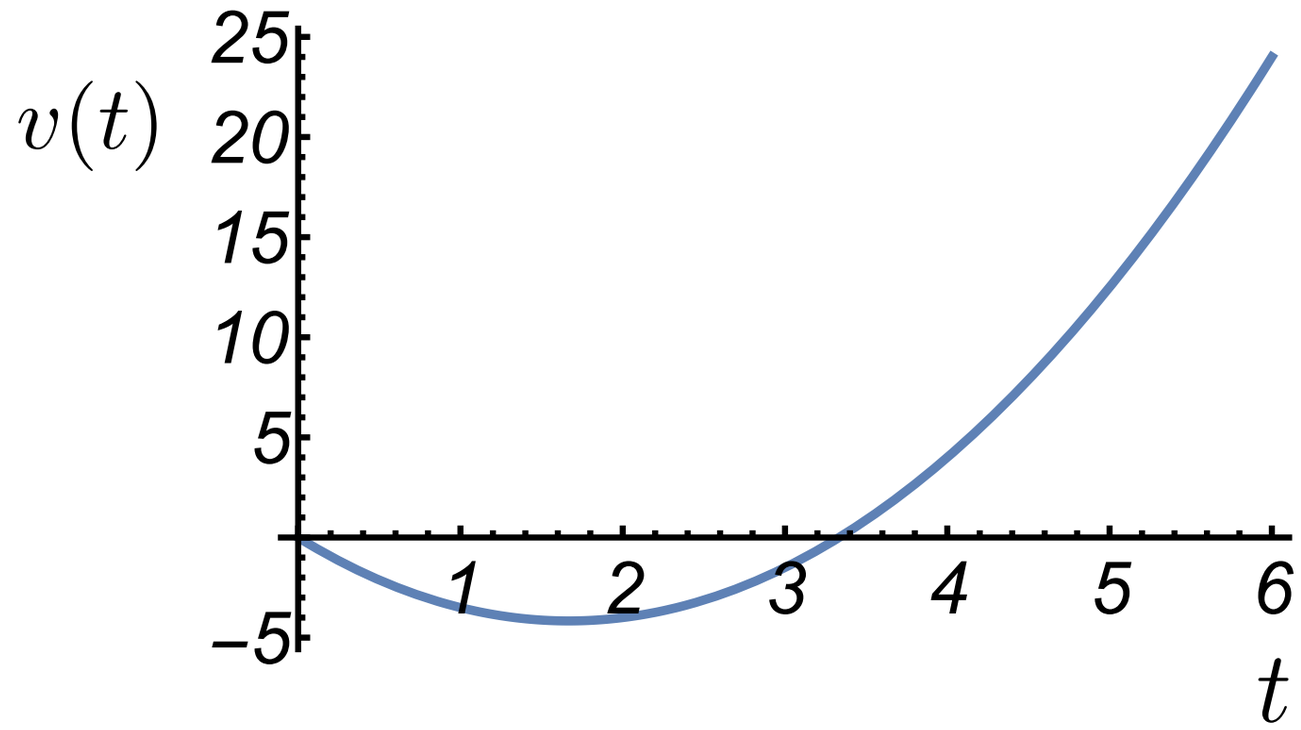


The Derivative

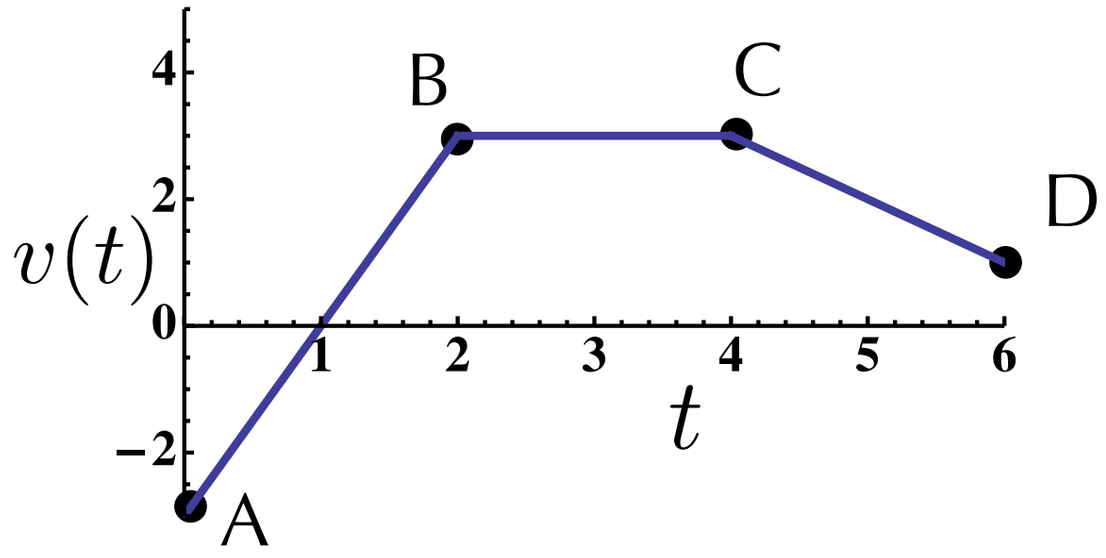
$$x(t) = \frac{1}{2}t^3 - \frac{5}{2}t^2$$



$$v(t) = \frac{3}{2}t^2 - 5t$$

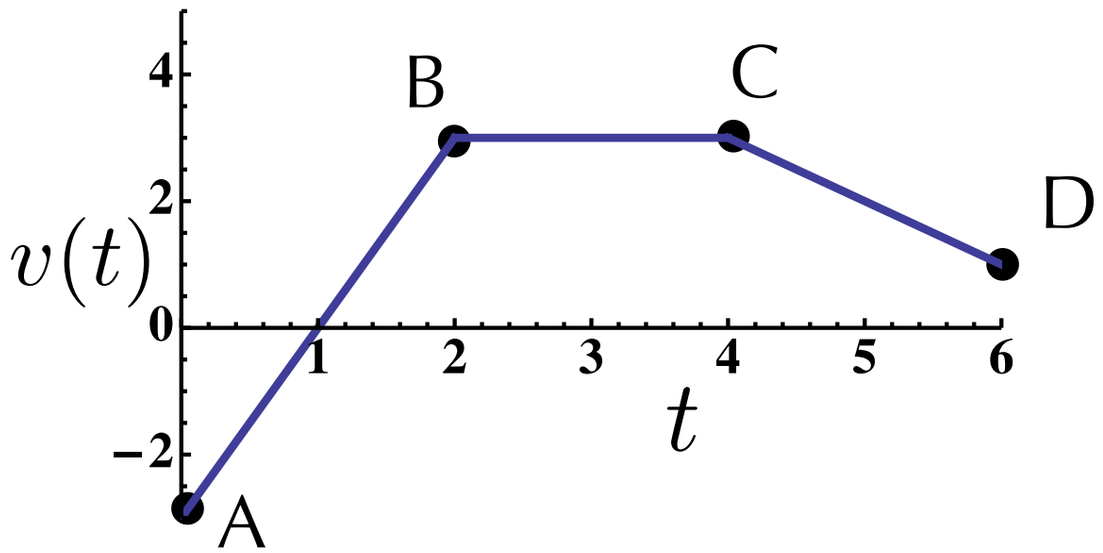


$$v(t) \rightarrow x(t)$$



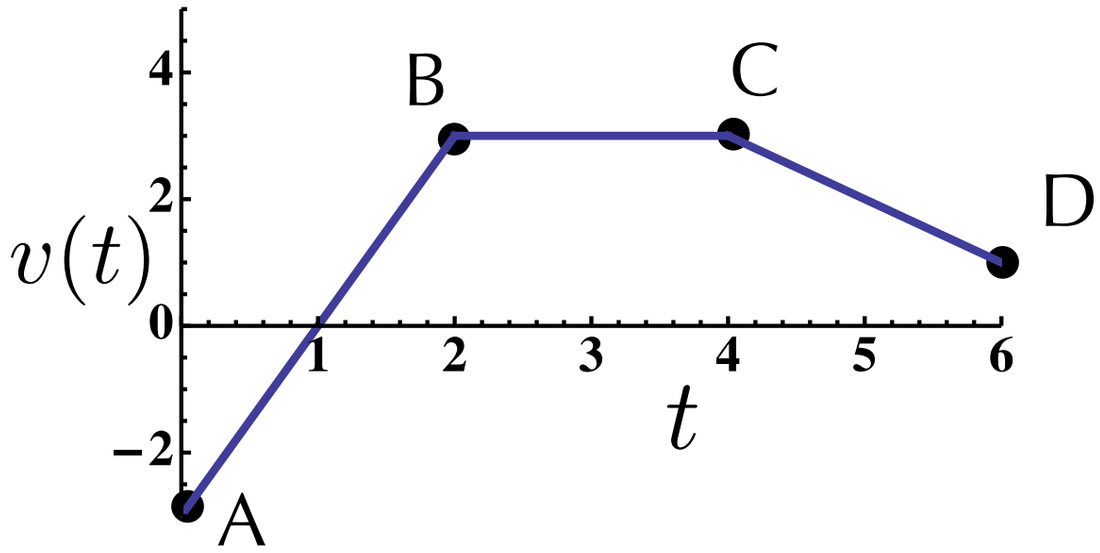
$$v(t) \rightarrow x(t)$$

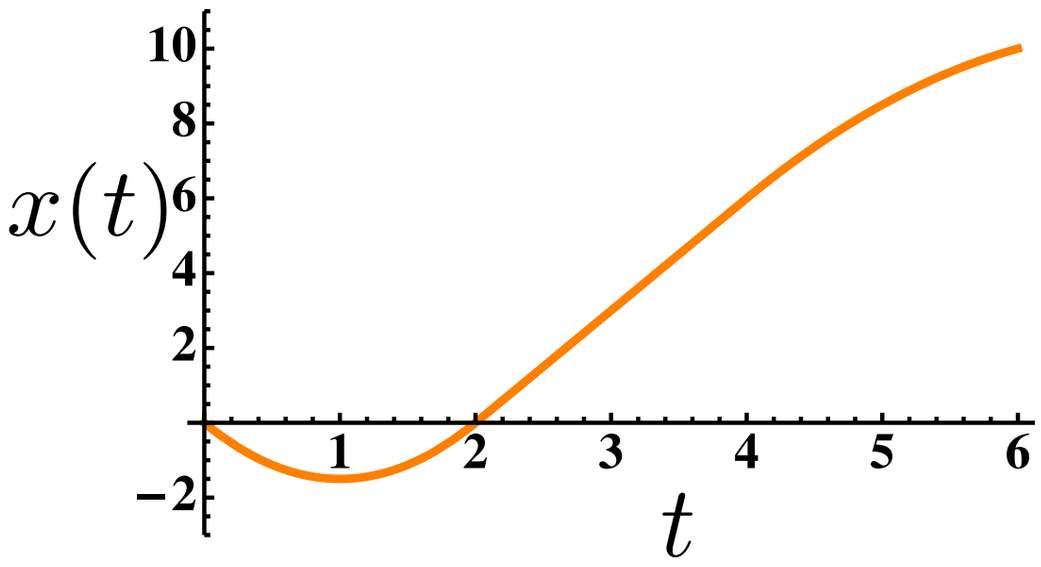
Draw the position-versus-time plot corresponding to the velocity-time graph shown (at t=0 the x=0).



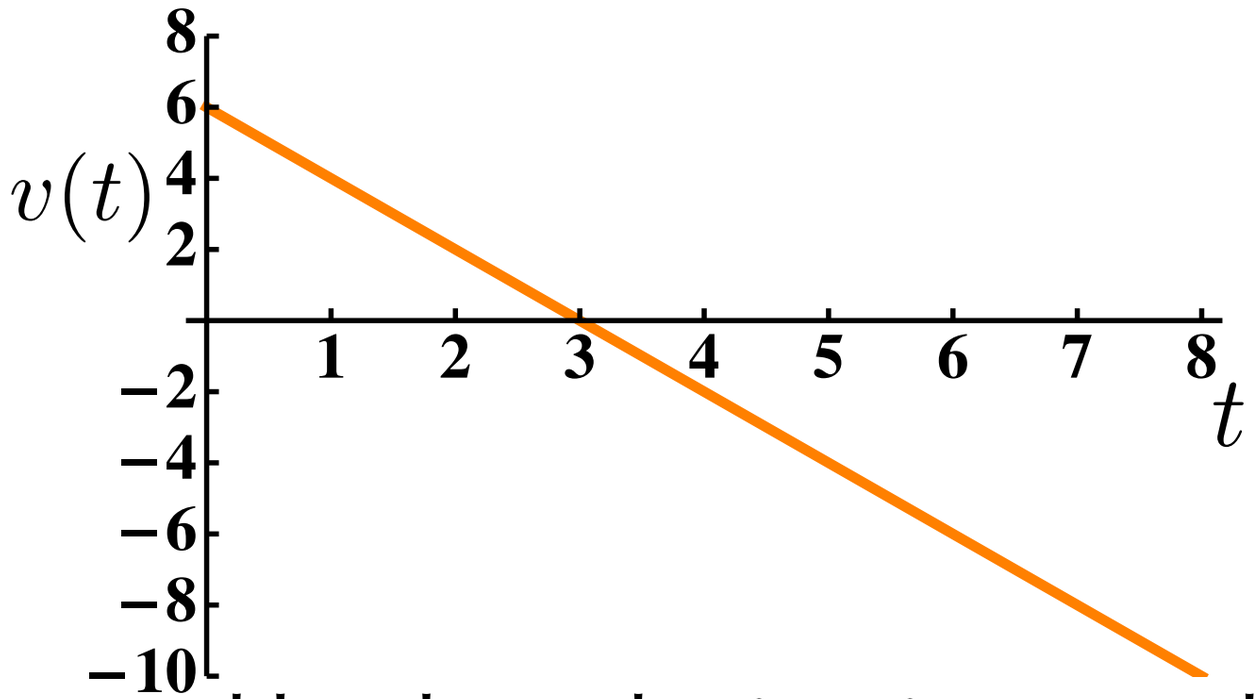
$$v(t) \rightarrow x(t)$$

Draw the position-versus-time plot corresponding to the velocity-time graph shown (at t=0 the x=0).





velocity → position exercise



The object represented by the velocity-time graph above is at x=7 at t=0. Does the object ever reach x=0? If so, at what time does this happen?

a) The object never reaches the origin.

b) The object reaches the origin at t = 3.

c) The object reaches the origin at t = 7.

d) The object reaches the origin at t = 6.

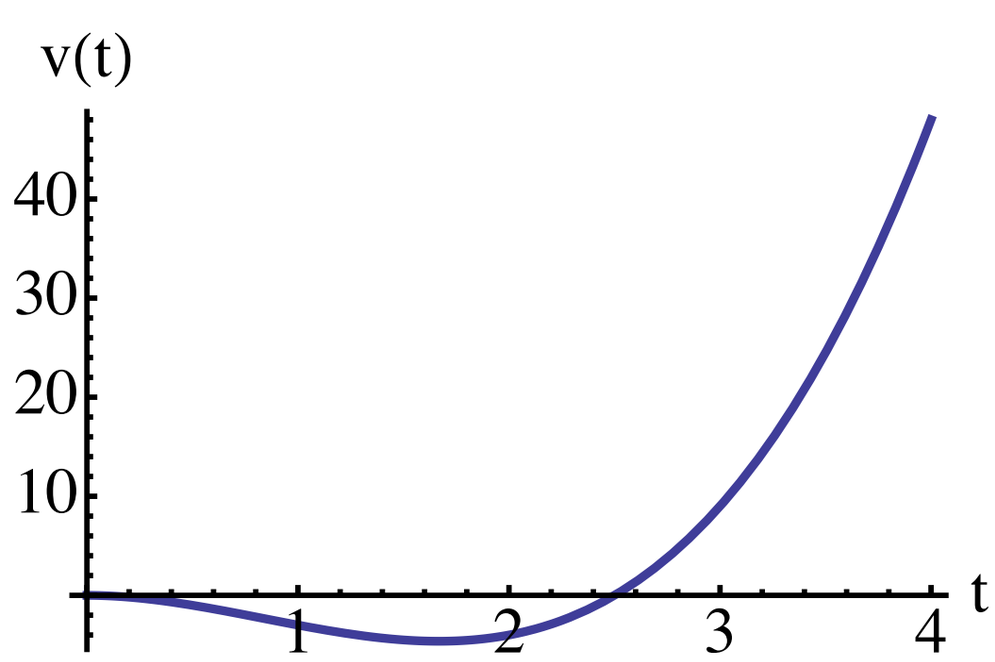
e) I have no idea.

Example Problem

The velocity of a particle is given by the expression

$$v(t) = 2t^3 - 5t^2$$

If the object's position at $t = 1$ is $x = 5$,
what is it's position when $t = 3$?

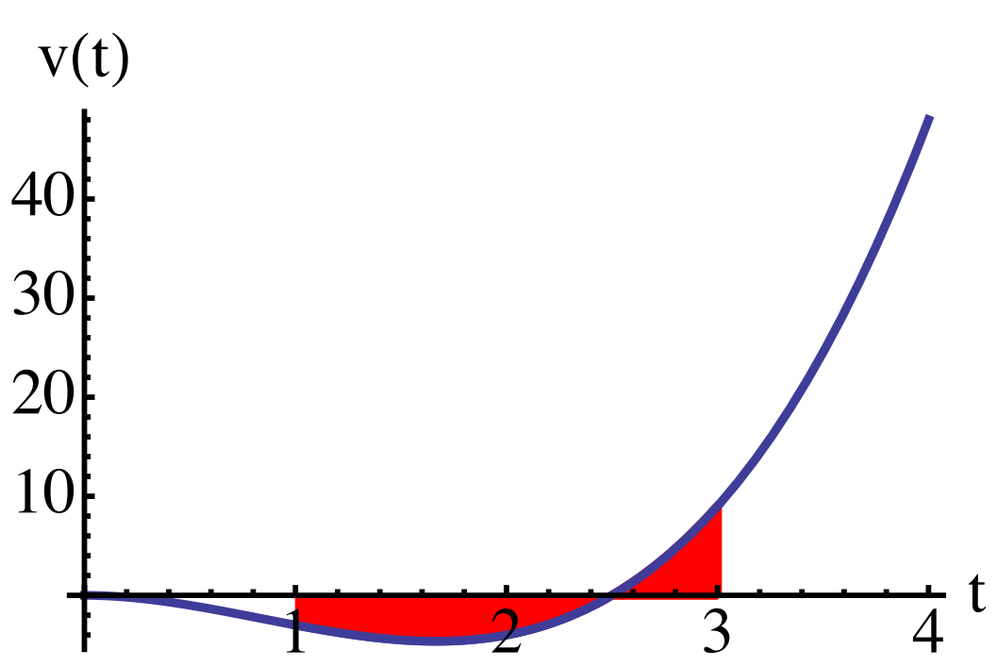


Example Problem

The velocity of a particle is given by the expression

$$v(t) = 2t^3 - 5t^2$$

If the object's position at $t = 1$ is $x = 5$,
what is it's position when $t = 3$?

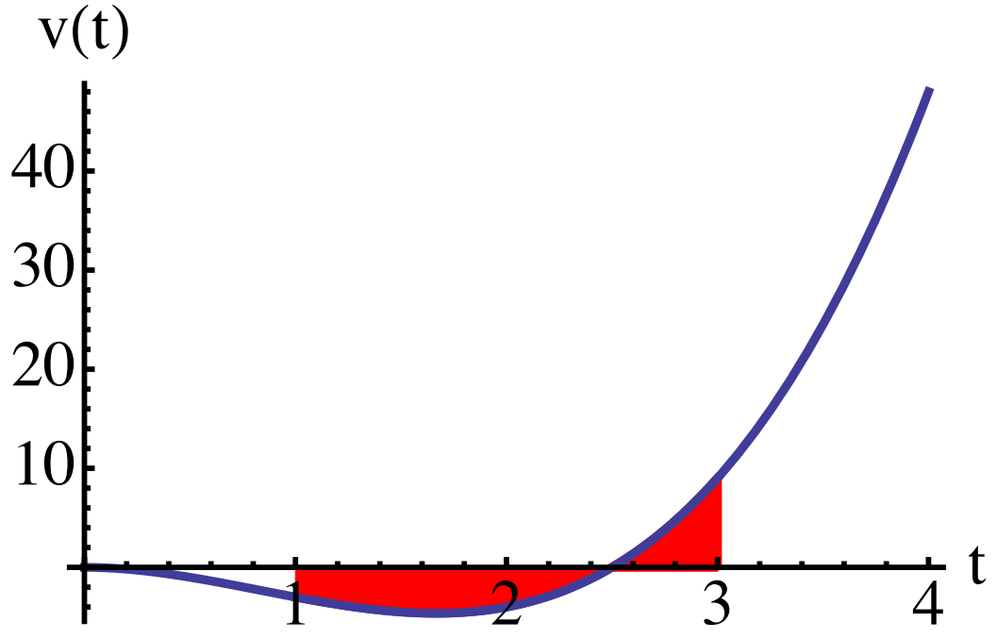


Example Problem

The velocity of a particle is given by the expression

$$v(t) = 2t^3 - 5t^2$$

If the object's position at $t = 1$ is $x = 5$,
what is it's position when $t = 3$?



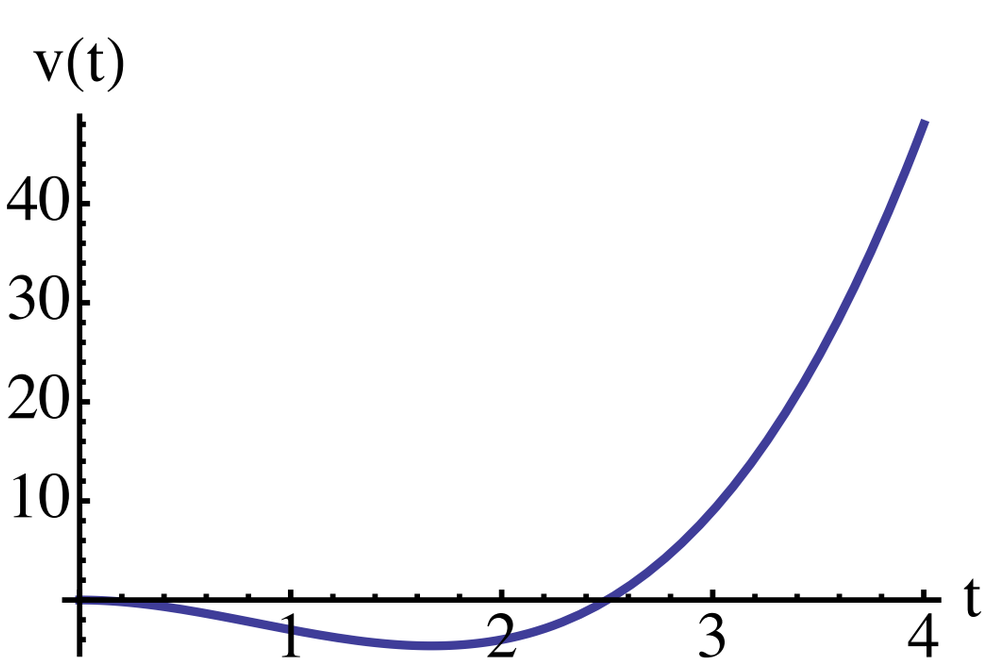
$$\Delta x = \int_1^3 2t^3 - 5t^2 dt = \frac{1}{2}t^4 - \frac{5}{3}t^3\Big|_1^3 = -\frac{10}{3}$$

Example Problem

The velocity of a particle is given by the expression

$$v(t) = 2t^3 - 5t^2$$

If the object's position at $t = 0$ is $x = 5$,
what is the object's position function $x(t)$?



Example Problem

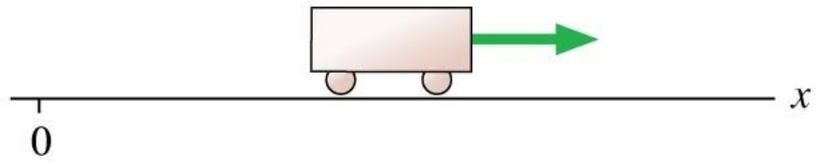
The velocity of a particle is given by the expression

$$v(t) = 2t^3 - 5t^2$$

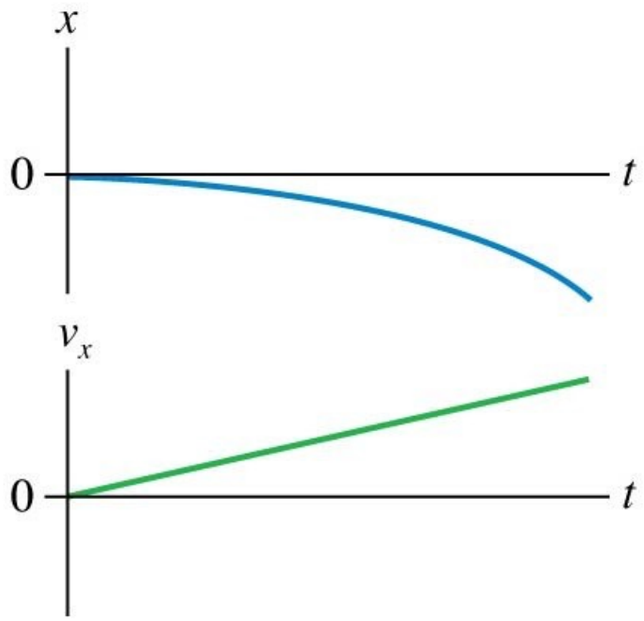
If the object's position at $t = 0$ is $x = 5$,
what is the object's position function $x(t)$?

Quiz

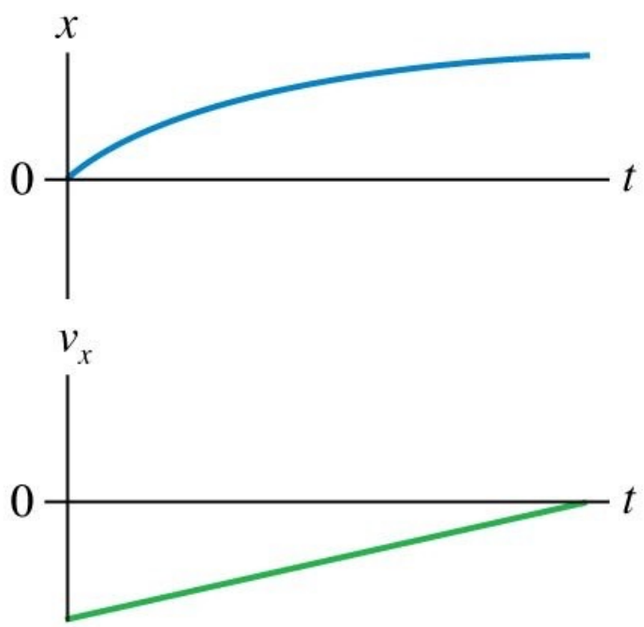
A cart slows down while moving away from the origin. What do the position and velocity graphs look like?



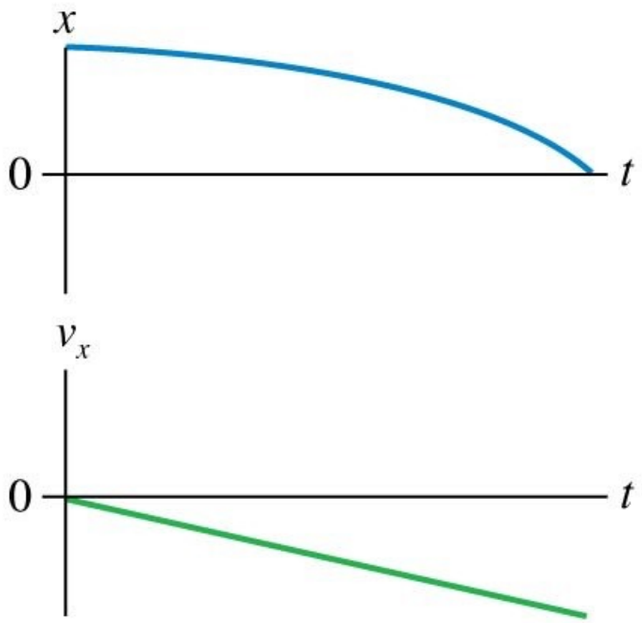
I



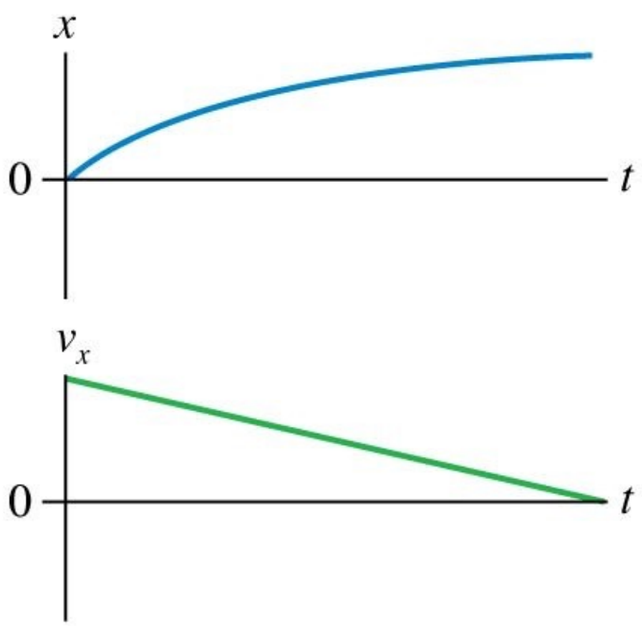
II



III

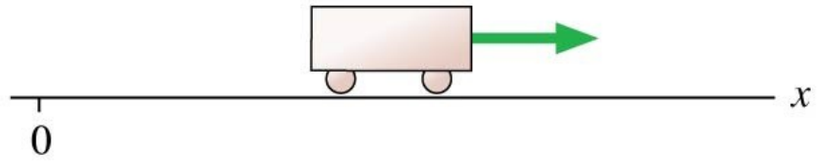


IV

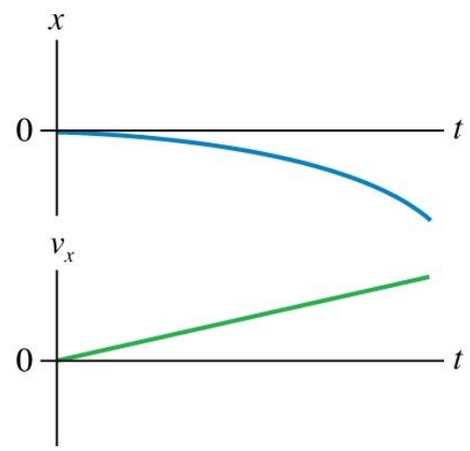


Quiz

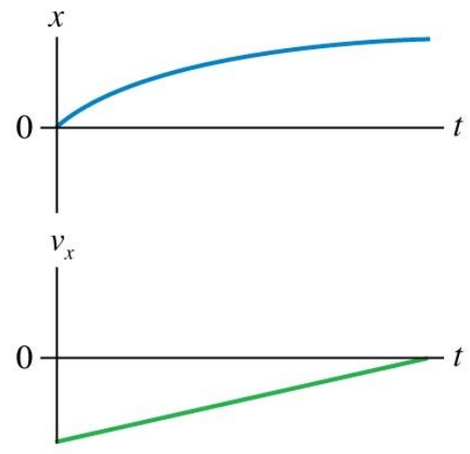
A cart slows down while moving away from the origin. What do the position and velocity graphs look like?



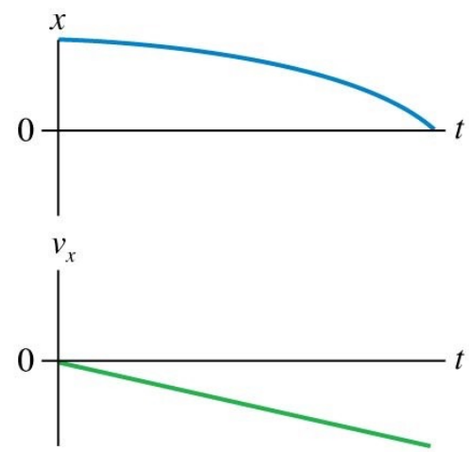
A.



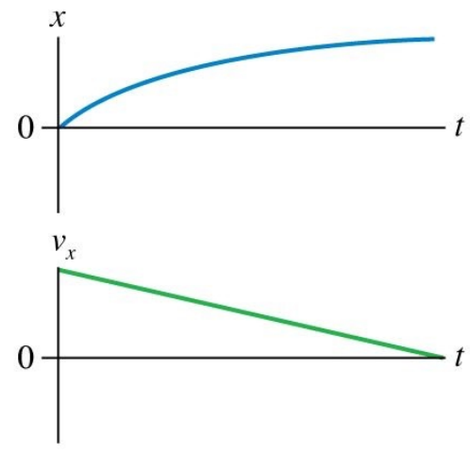
B.



C.

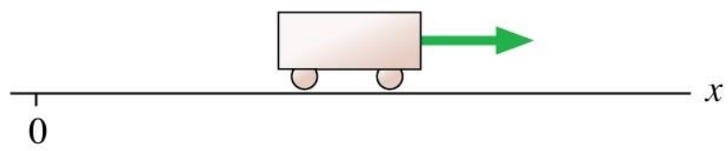


D.

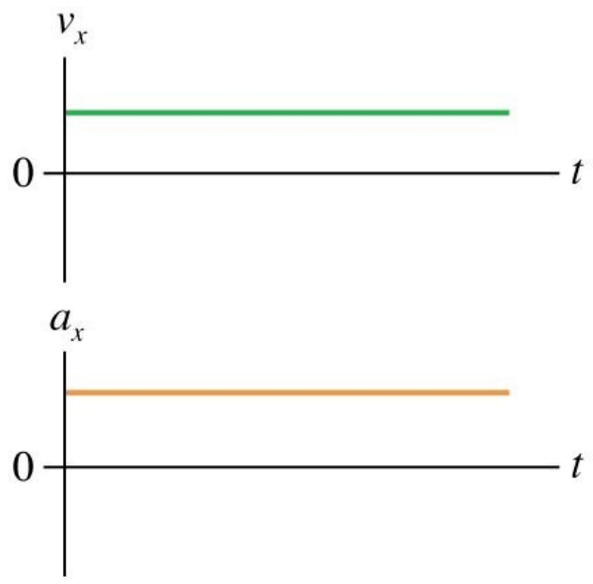


Quiz

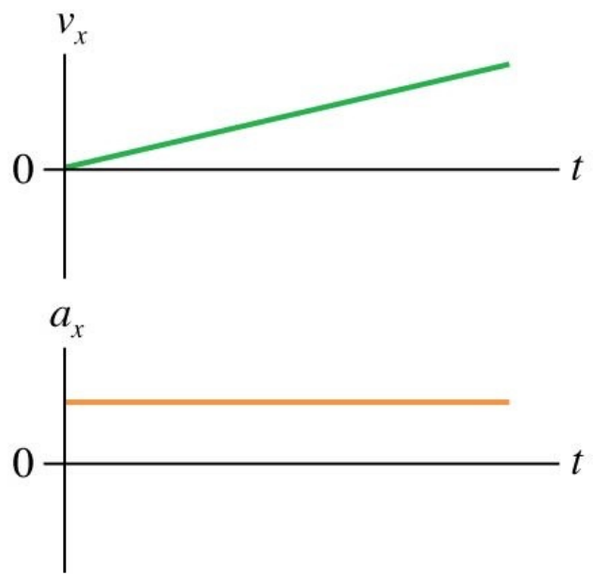
A cart speeds up while moving away from the origin. What do the velocity and acceleration graphs look like?



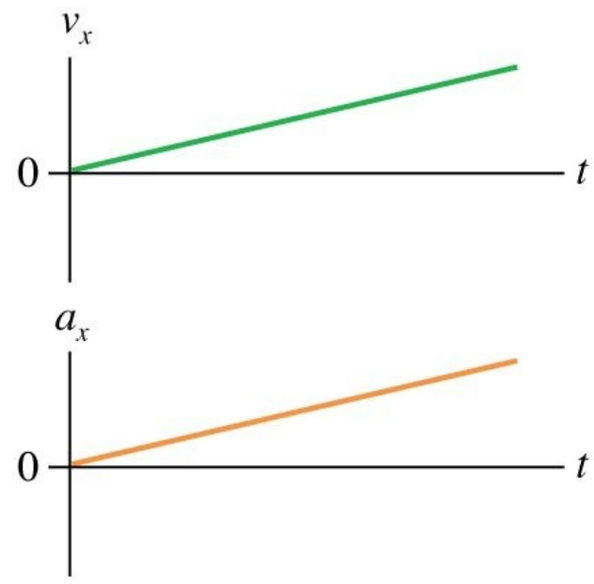
A.



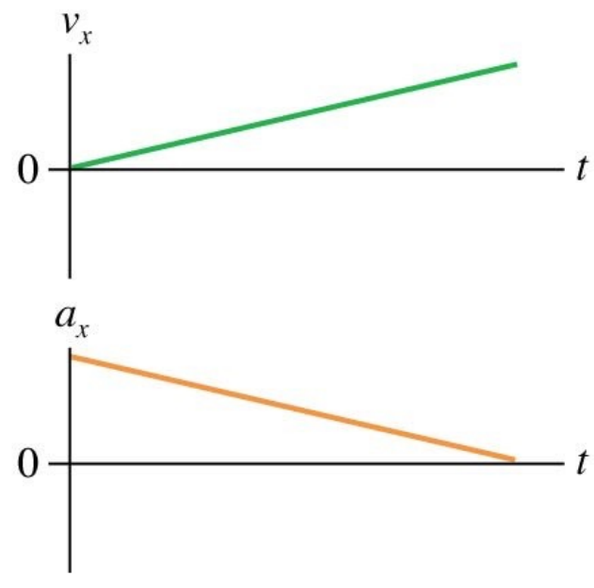
B.



C.

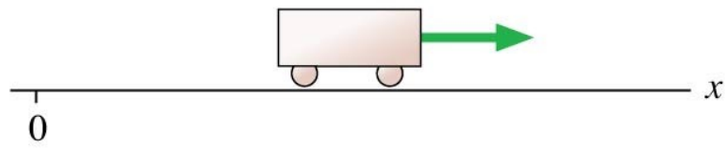


D.

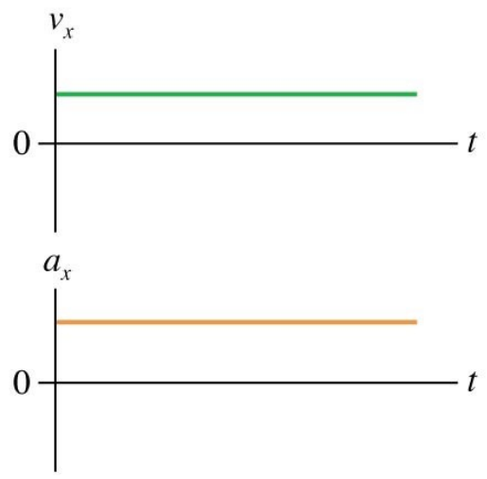


Quiz

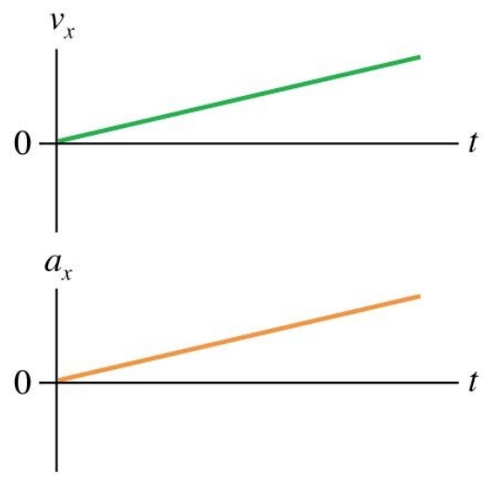
A cart speeds up while moving away from the origin. What do the velocity and acceleration graphs look like?



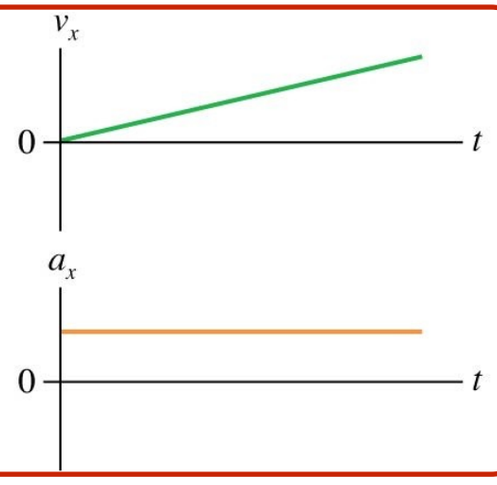
A.



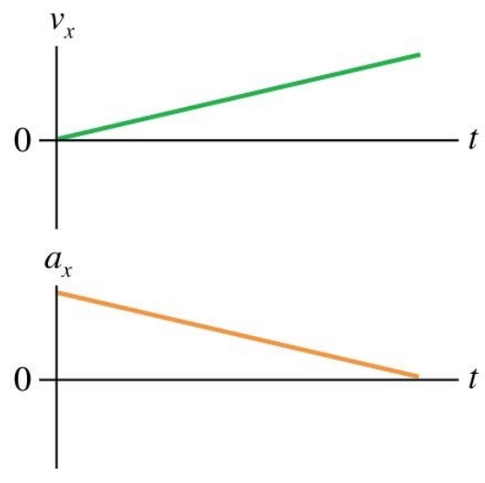
C.



B.

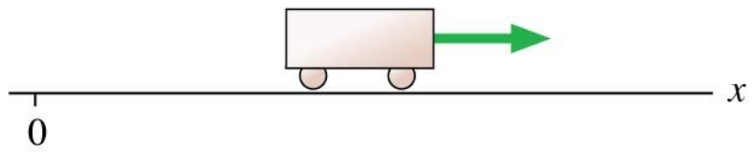


D.

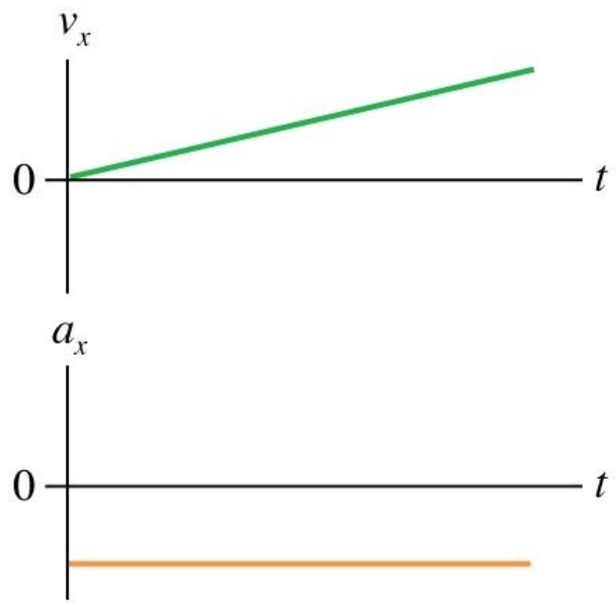


Quiz

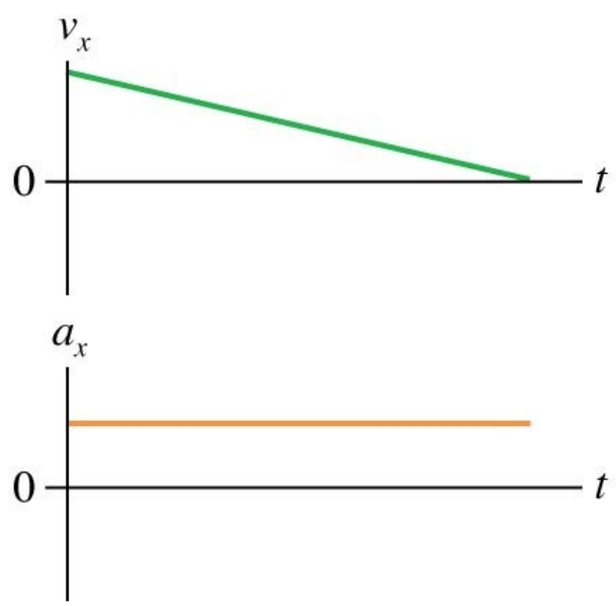
A cart slows down while moving away from the origin. What do the velocity and acceleration graphs look like?



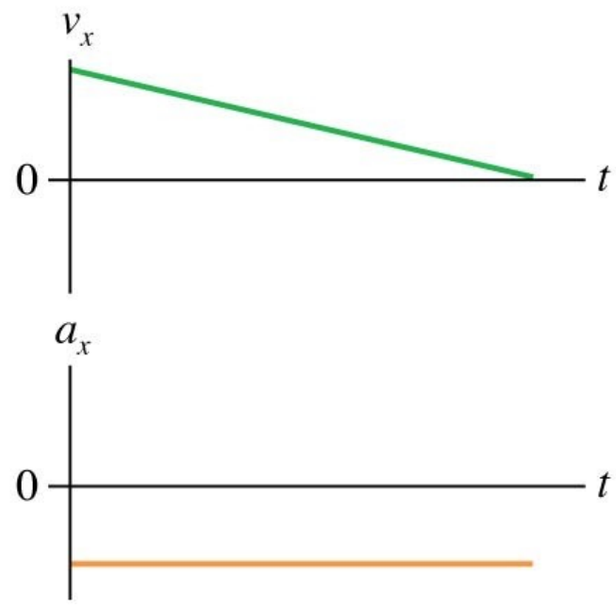
A.



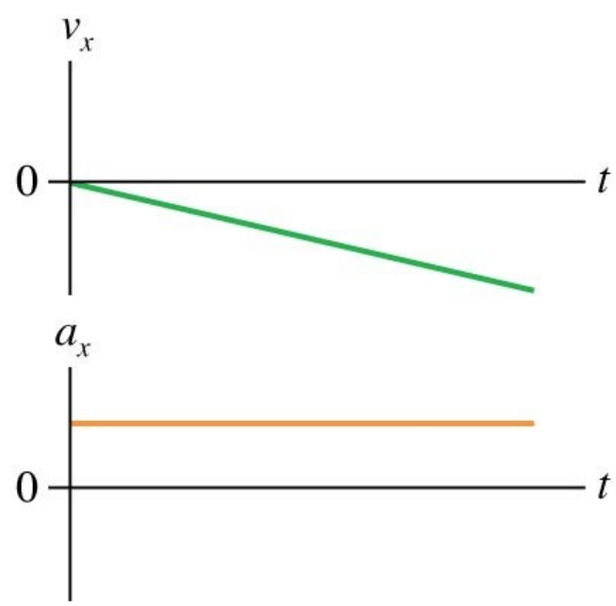
B.



C.

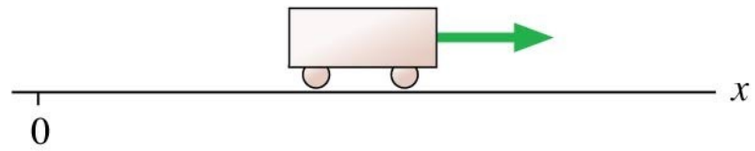


D.

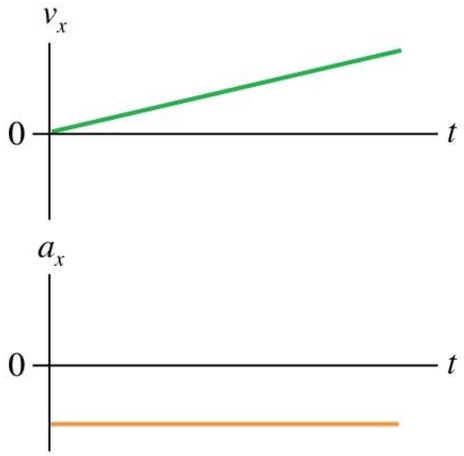


Quiz

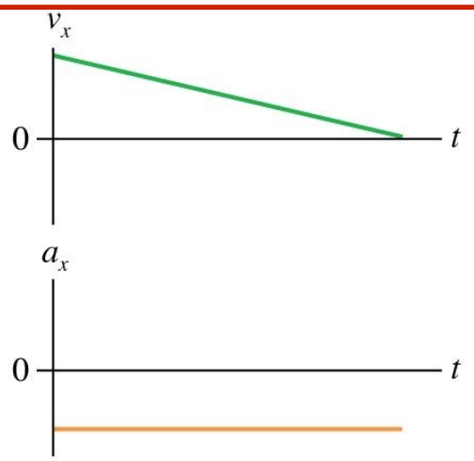
A cart slows down while moving away from the origin. What do the velocity and acceleration graphs look like?



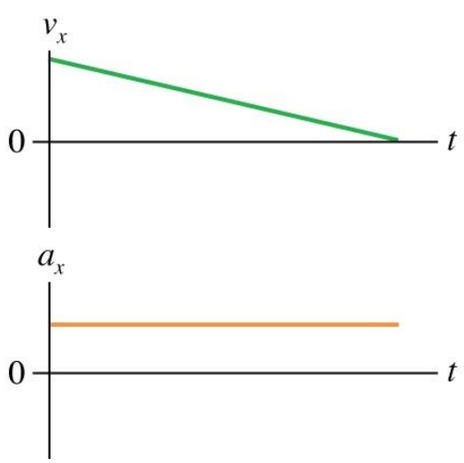
A.



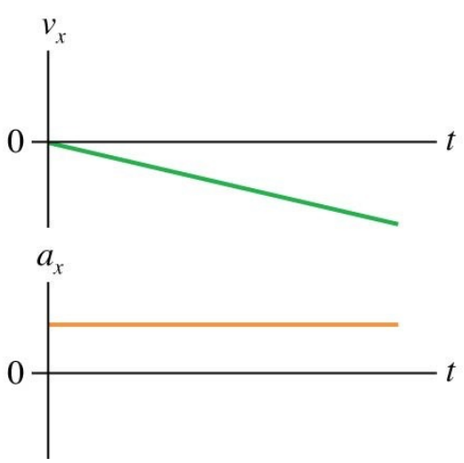
C.



B.

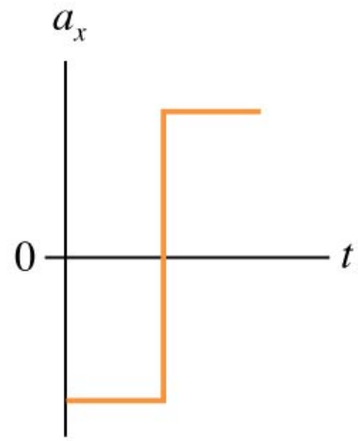


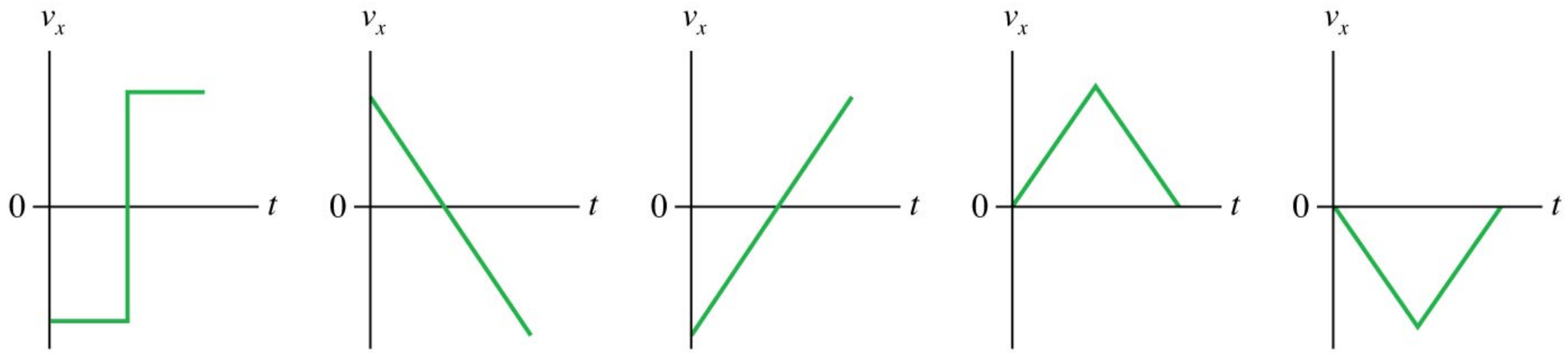
D.



Quiz

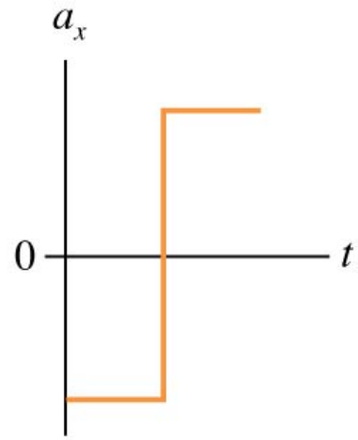
Which velocity-versus-time graph goes with this acceleration graph?

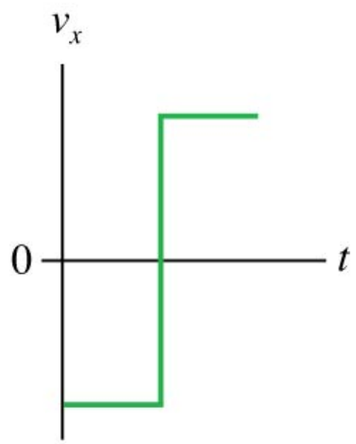




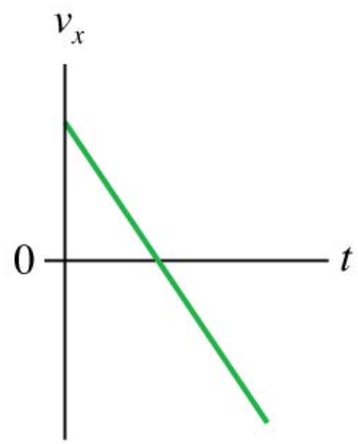
Quiz

Which velocity-versus-time graph goes with this acceleration graph?

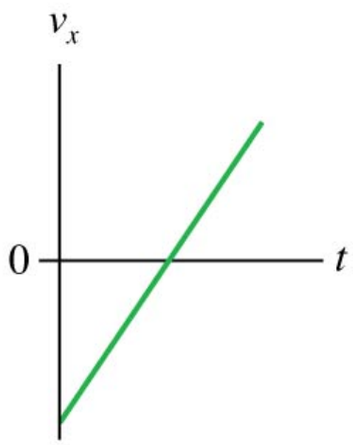




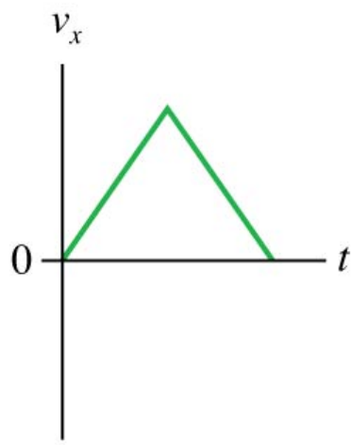
A.



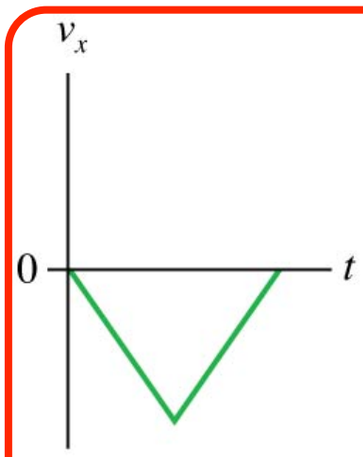
B.



C.

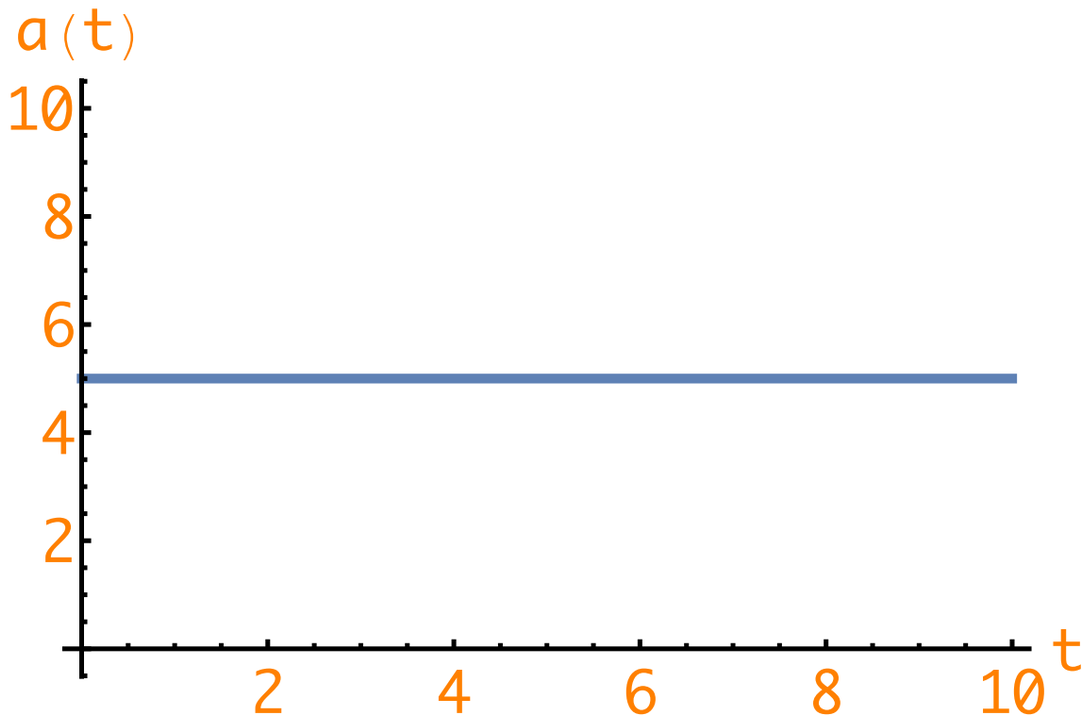


D.



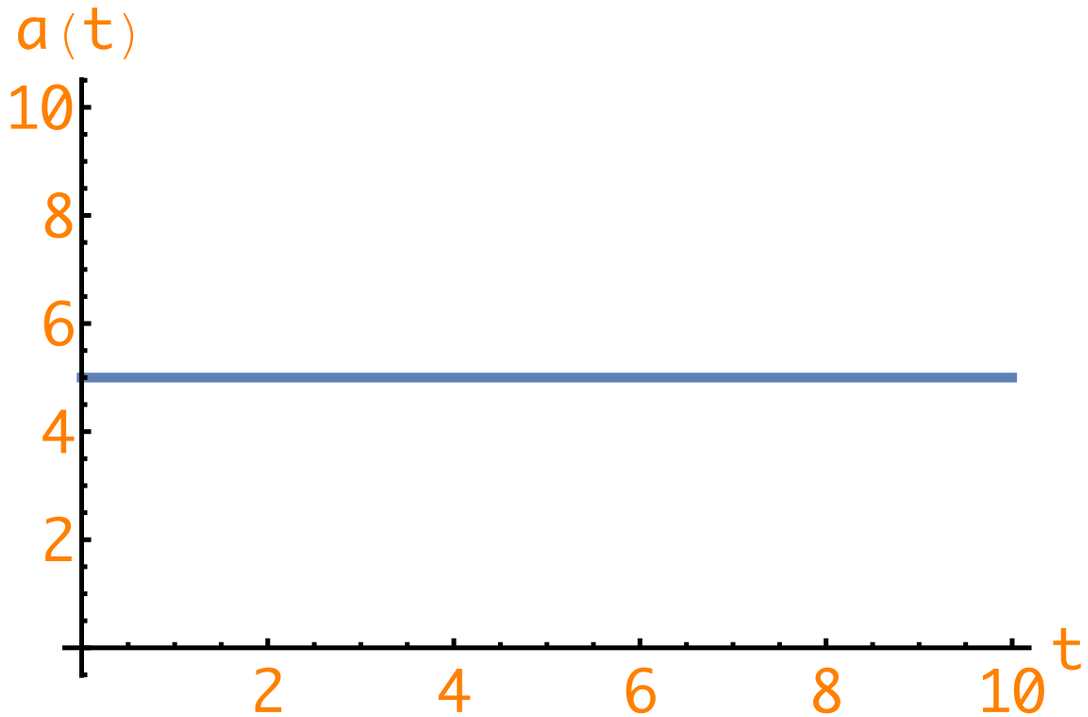
E.

Kinematic Equations



The initial velocity is 20 m/s and the initial position is 10 m.

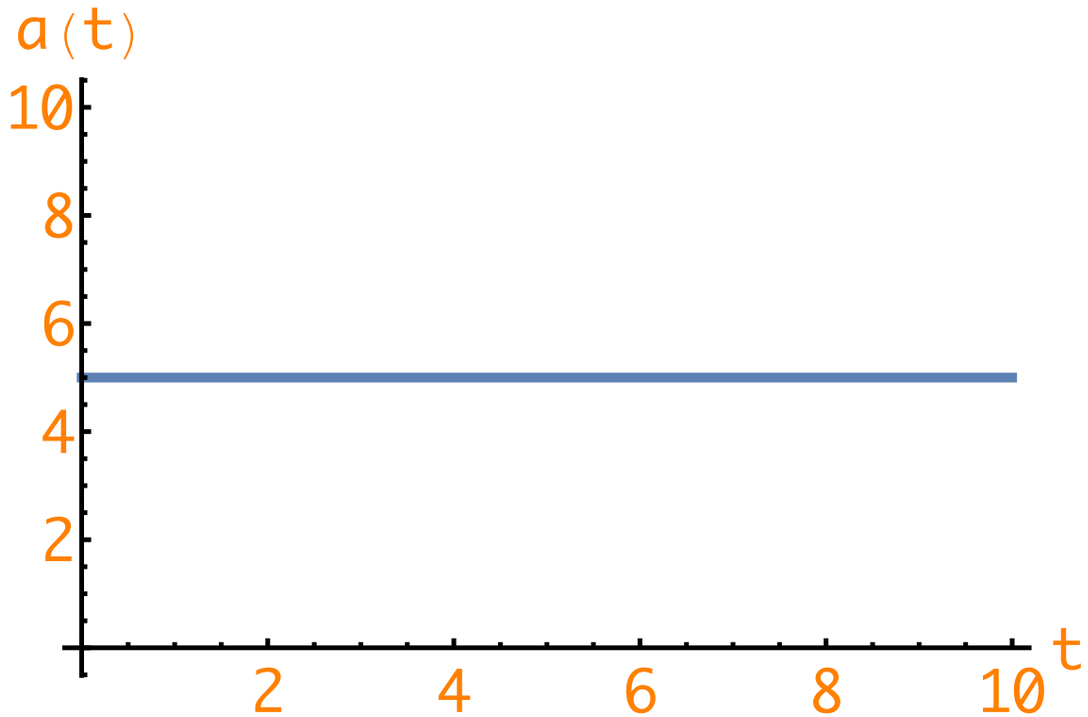
Kinematic Equations



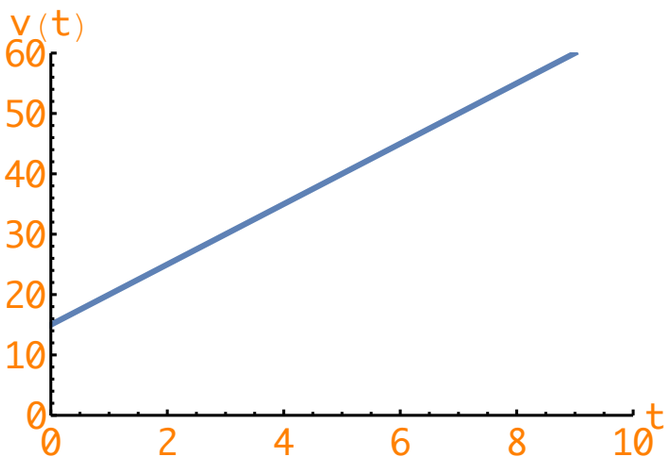
A.Write down the function shown at the left for the acceleration.
B. Integrate the function once to get the velocity function.
C. Integrate the velocity function to get the position function.
D. What do these functions look like?

The initial velocity is 20 m/s and the initial position is 10 m.

Kinematic Equations

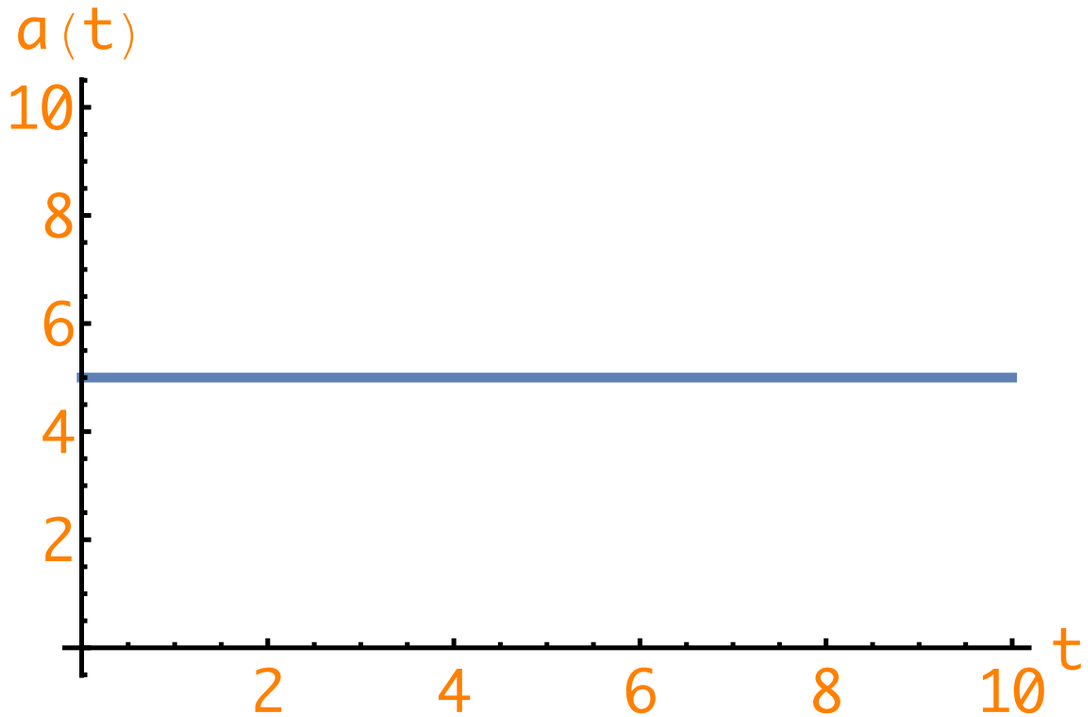


A.Write down the function shown at the left for the acceleration.
B. Integrate the function once to get the velocity function.
C. Integrate the velocity function to get the position function.
D. What do these functions look like?



The initial velocity is 20 m/s and the initial position is 10 m.

Kinematic Equations

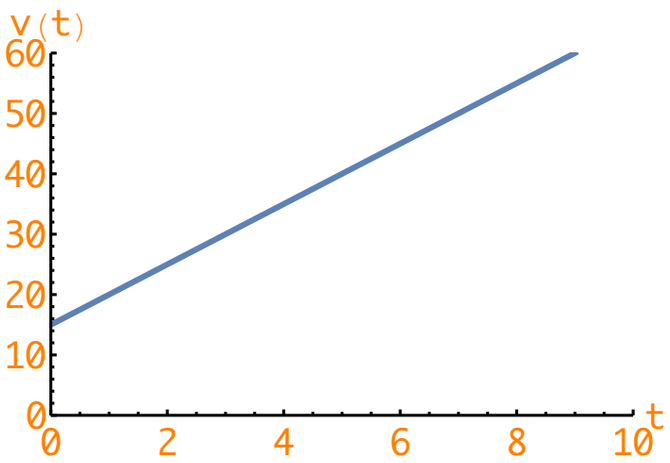


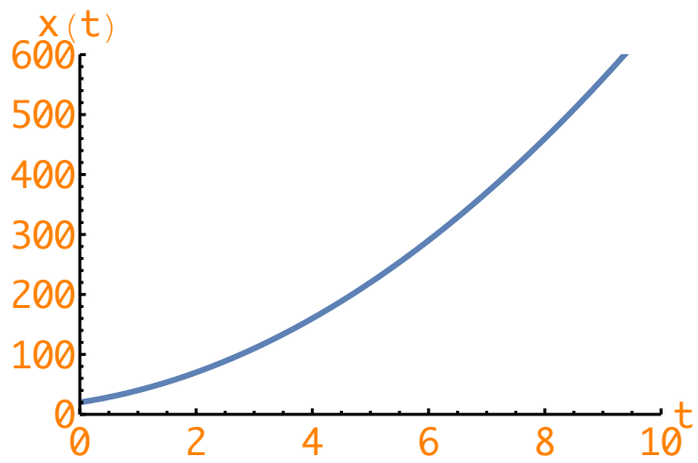
A.Write down the function shown at the left for the acceleration.

B. Integrate the function once to get the velocity function.

C. Integrate the velocity function to get the position function.

D. What do these functions look like?





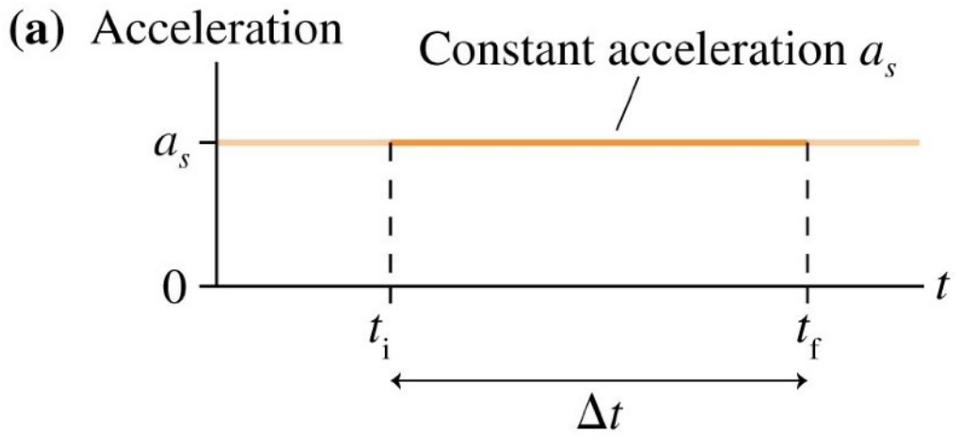
The initial velocity is 20 m/s and the initial position is 10 m.

Kinematic Equations for **constant** acceleration

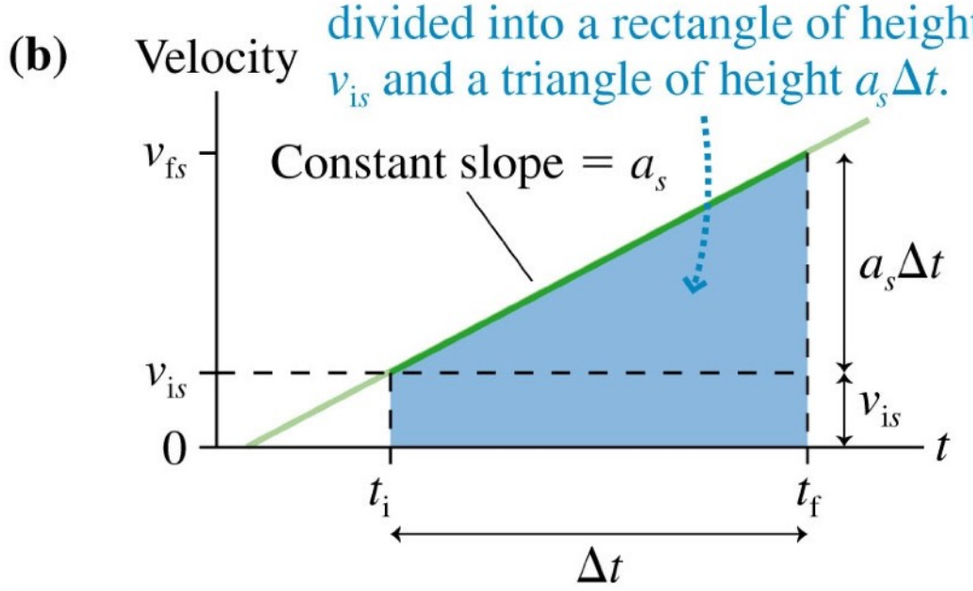
$$v_f = v_i + a\Delta t$$

$$x_f = x_i + v_i\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$v_f^2 = v_i^2 + 2a\Delta x$$



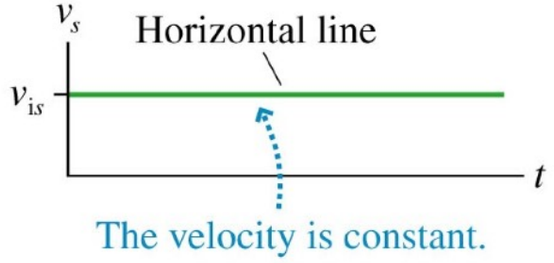
Displacement Δs is the area under the curve. The area can be divided into a rectangle of height v_{is} and a triangle of height $a_s\Delta t$.

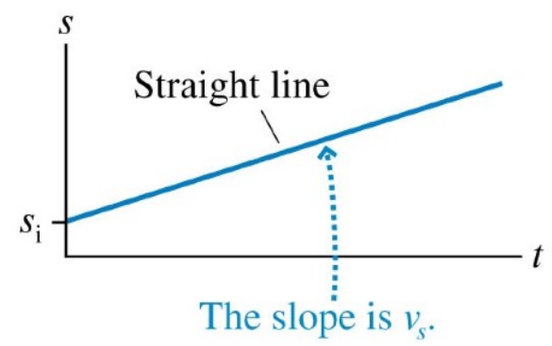


The Kinematic Equation of Constant Acceleration

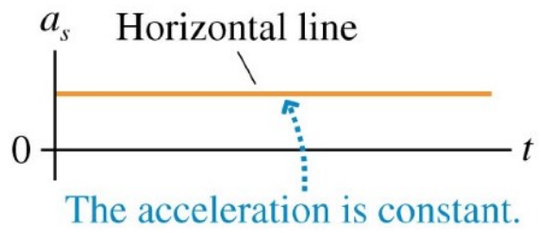
Motion with constant velocity and constant acceleration. These graphs assume $s_i = 0$, $v_{is} > 0$, and (for constant acceleration) $a_s > 0$.

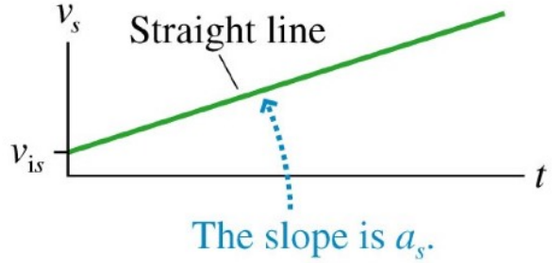
(a) Motion at constant velocity

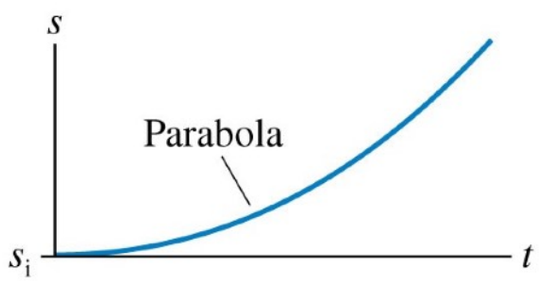




(b) Motion at constant acceleration







Let's do a problem!

You are driving to the grocery store at 20 m/s. You are 110 m from an intersection when the traffic light turns red. Your reaction time is 0.5 s and your car brakes at constant acceleration.

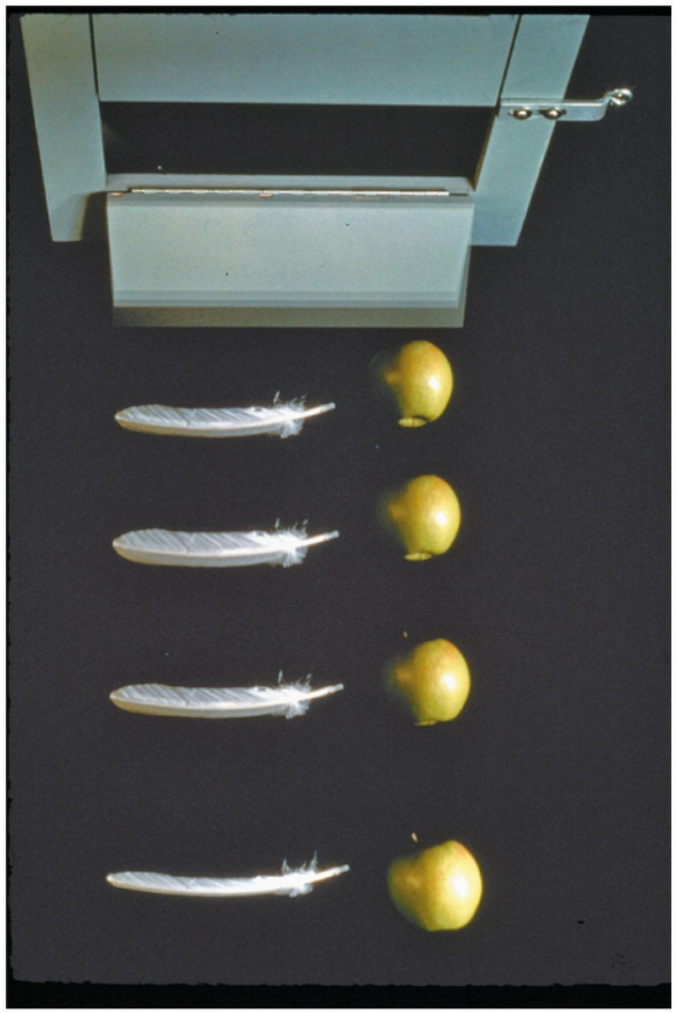
- How far are you from the intersection when you begin to brake?
- What acceleration will bring you to rest right at the intersection?
- How long does it take you to stop after the light turns red?

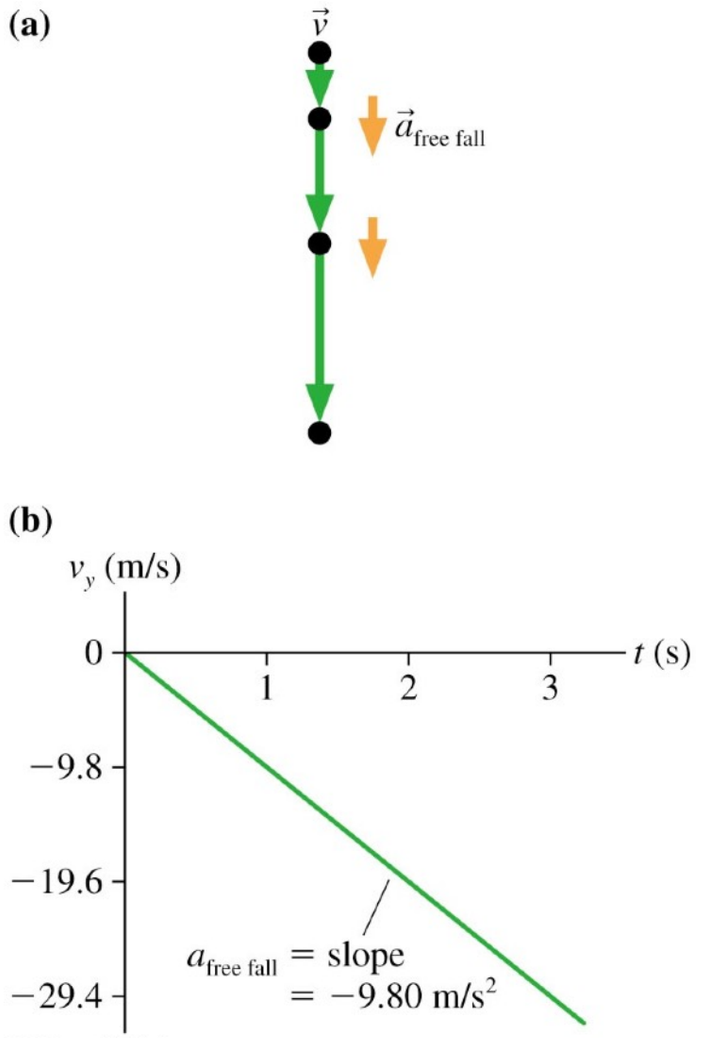
Now you try one..

A porsche challenges a Honda to a 400 m race. Because the Porsche's acceleration of $3.5\frac{m}{s^2}$ is larger than the Honda's $3.0\,\frac{m}{s^2}$, the Honda gets a 1.0 s head start. Who wins the race?

You are driving your new Lamborgini diablo down the road at a modest speed when you decide to step on the gas. You accelerate at a rate of $4.3\frac{m}{s^2}$, and after traveling 1000 meters your speedometer says that you are going 100 m/s. What was your speed before you started accelerating?

Free fall (acceleration due to gravity)





$$\vec{a}_{\text{free fall}} = (9.80\ \text{m/s}^2, \text{vertically downward})$$

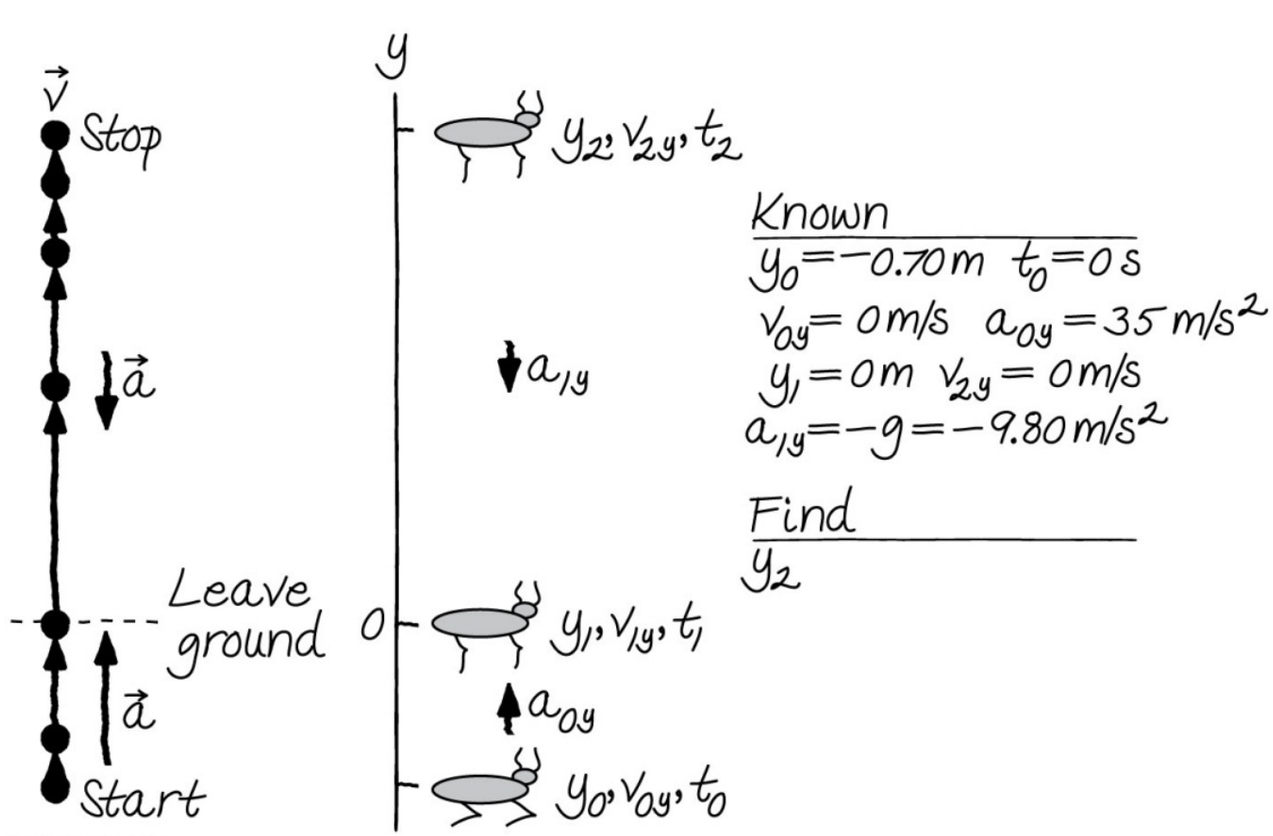
Galileo was right

Springbok leap

The springbok, an antelope found in Africa, gets its name from its remarkable jumping ability. When startled, a springbok will leap straight up into the air - a maneuver called a “pronk”. A spingbok goes into a crouch to perform a pronk. It then extends its legs forcefully, accelerating at 35 m/s^2 for 0.7 m as its legs straighten. Legs fully extended, it leaves the ground and rises in the air. How high does it go?

Springbok leap

The springbok, an antelope found in Africa, gets its name from its remarkable jumping ability. When startled, a springbok will leap straight up into the air - a maneuver called a “pronk”. A spingbok goes into a crouch to perform a pronk. It then extends its legs forcefully, accelerating at 35 m/s^2 for 0.7 m as its legs straighten. Legs fully extended, it leaves the ground and rises in the air. How high does it go?



Known

$y_0 = -0.70\,m \quad t_0 = 0\,s$

$v_{0y} = 0\,m/s \quad a_{0y} = 35\,m/s^2$

$y_1 = 0\,m \quad v_{2y} = 0\,m/s$

$a_{1y} = -g = -9.80\,m/s^2$

Find

y_2

Your turn...

You are standing on top of the empire state building, which is 443 meters tall, and you decide to throw a penny straight down towards the street. Your throw gives the penny an initial speed of 15 m/s. How fast is the penny going when it reaches the ground?

You throw a baseball straight up into the air as hard as you can, giving it an initial speed of 25 m/s. How long before the ball hits the ground?