Today: Section 2.4

$\boxed{L5}$

Constant acceleration

Today: Section 2.4

Wednesday: Sections 2.5 & 2.6

$\boxed{L5}$

Today: Section 2.4

Wednesday: Sections $\underbrace{2.5}_{\text{Free Fall}}$ & 2.6

$\boxed{L5}$

$\boxed{L5}$

Today: Section 2.4

Wednesday: Sections 2.5 & $\underbrace{2.6}$

Velocity & position by integration

Today: Section 2.4

Wednesday: Sections 2.5 & 2.6

$\boxed{L5}$

Velocity & position by integration

We will touch on some of this today

ASU

Today: Section 2.4

$\boxed{L5}$

Wednesday: Sections 2.5 & 2.6

HW#1 Due Wednesday

Today: Section 2.4

$\boxed{L5}$

Wednesday: Sections 2.5 & 2.6

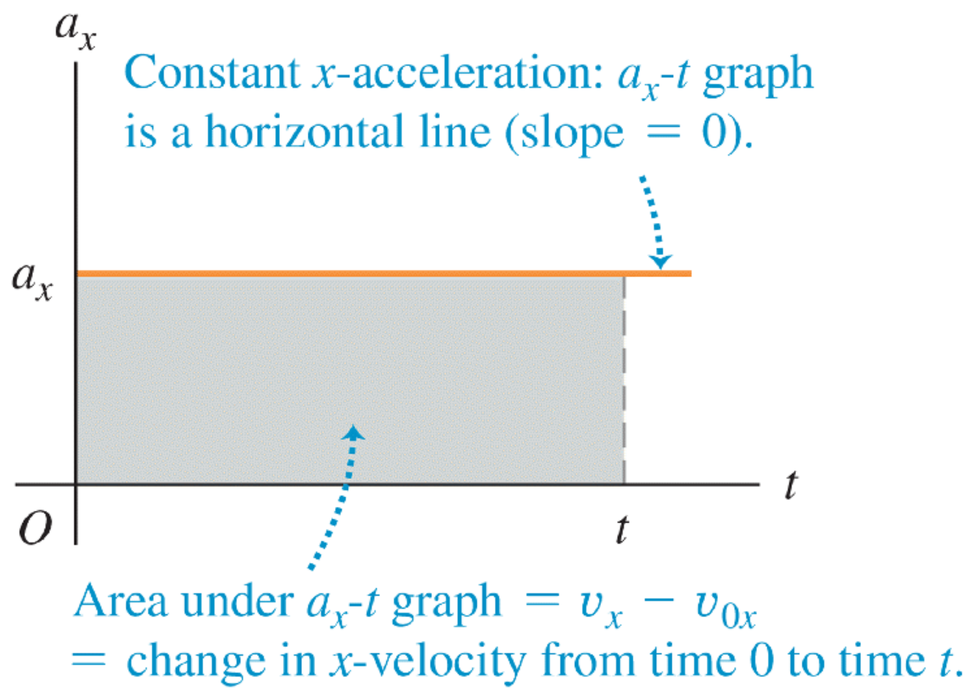
HW#1 Due Wednesday

HW#2 Due Friday

Constant acceleration

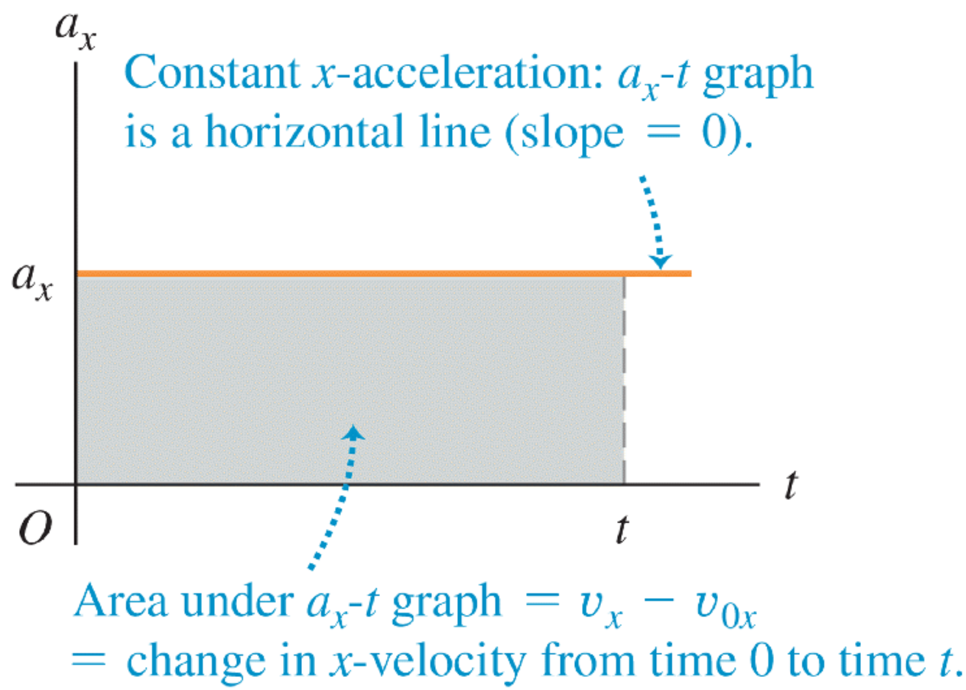
Constant acceleration

$a = \text{constant}$



Constant acceleration

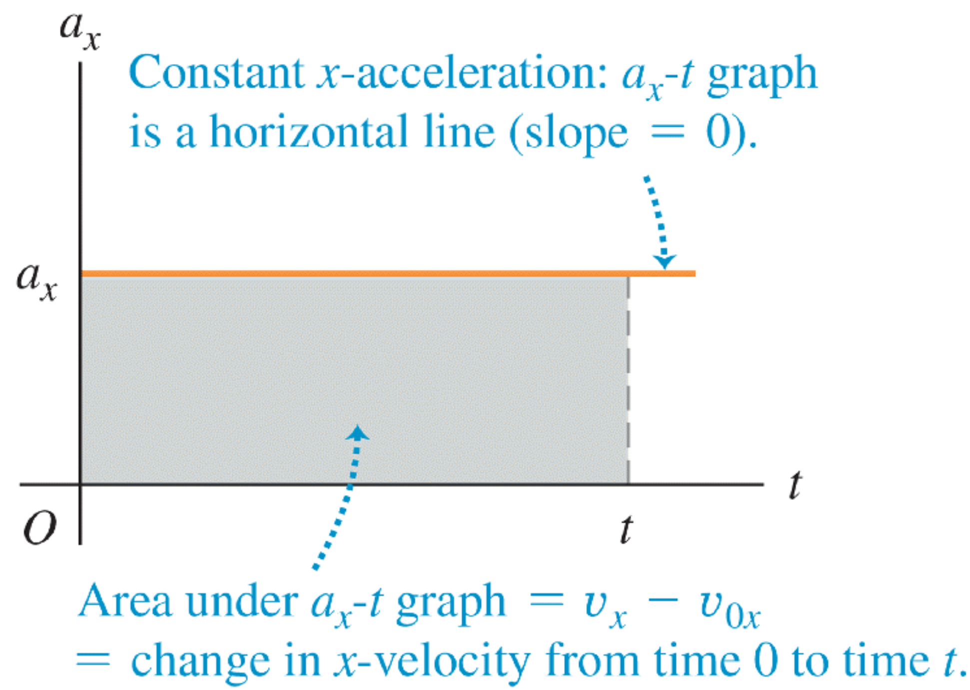
$a = \text{constant}$ & $a = \frac{dv}{dt}$



Constant acceleration

$a = \text{constant}$ & $a = \frac{dv}{dt}$ so

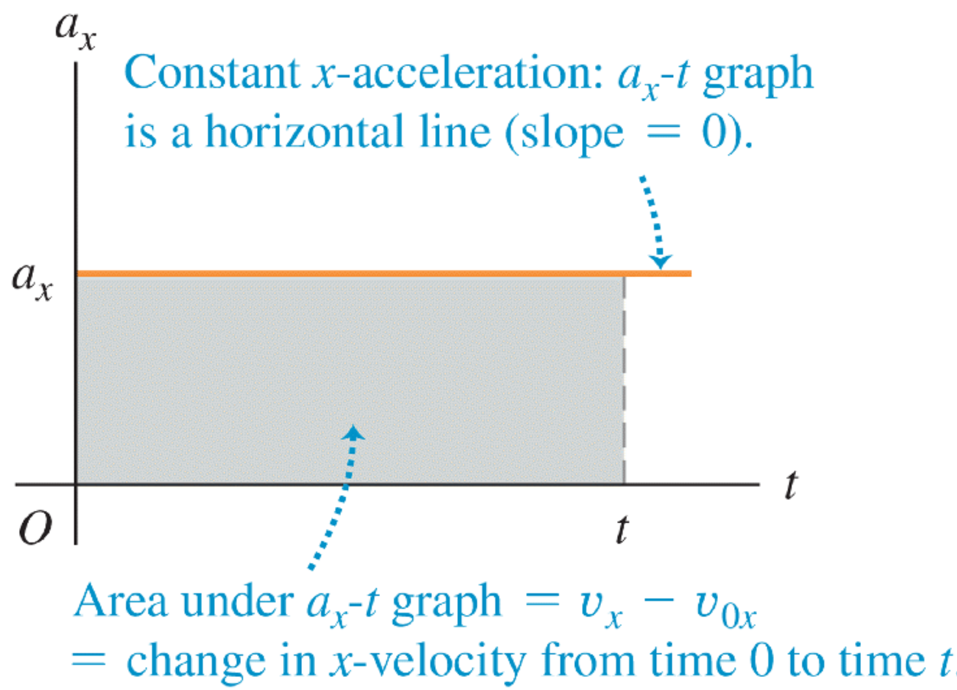
$$\int a\,dt = \int \frac{dv}{dt}\,dt$$



Constant acceleration

$a = \text{constant}$ & $a = \frac{dv}{dt}$ so

$$\underbrace{\int a\,dt}_{\text{area under a vs t plot}} = \int \frac{dv}{dt}\,dt$$

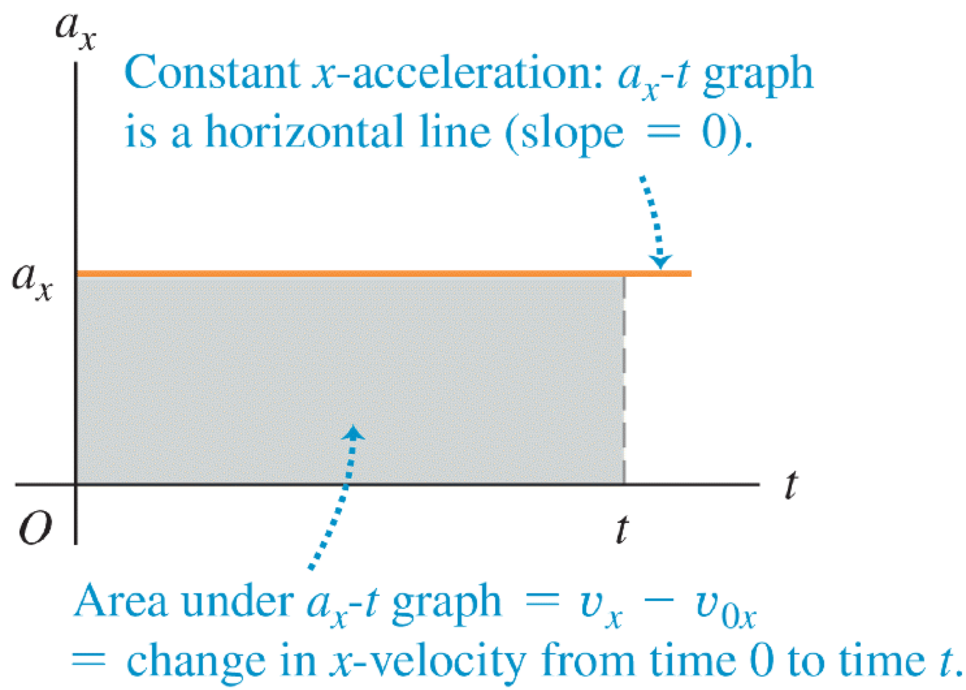


Constant acceleration

$a = \text{constant}$ & $a = \frac{dv}{dt}$ so

$$\int a\,dt = \int \frac{dv}{dt}\,dt$$

$$\Rightarrow a\int dt = \int \frac{dv}{dt}\,dt$$



ASU

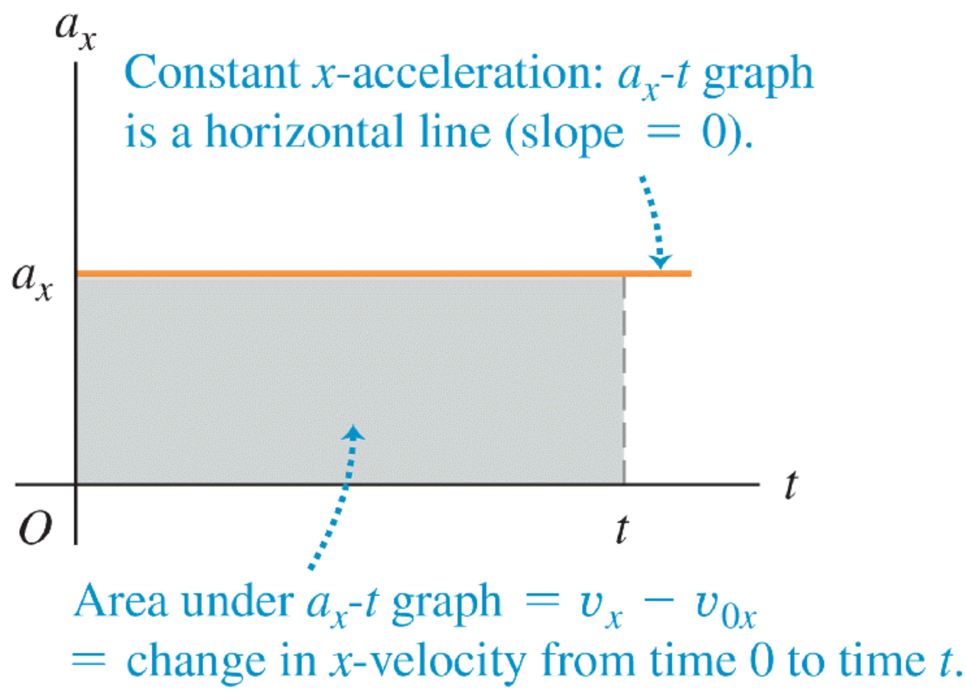
Constant acceleration

$a = \text{constant}$ & $a = \frac{dv}{dt}$ so

$$\int a\,dt = \int \frac{dv}{dt}\,dt$$

$$\Rightarrow a\int dt = \int \frac{dv}{dt}\,dt$$

But $dv = \frac{dv}{dt}\,dt$



Constant acceleration

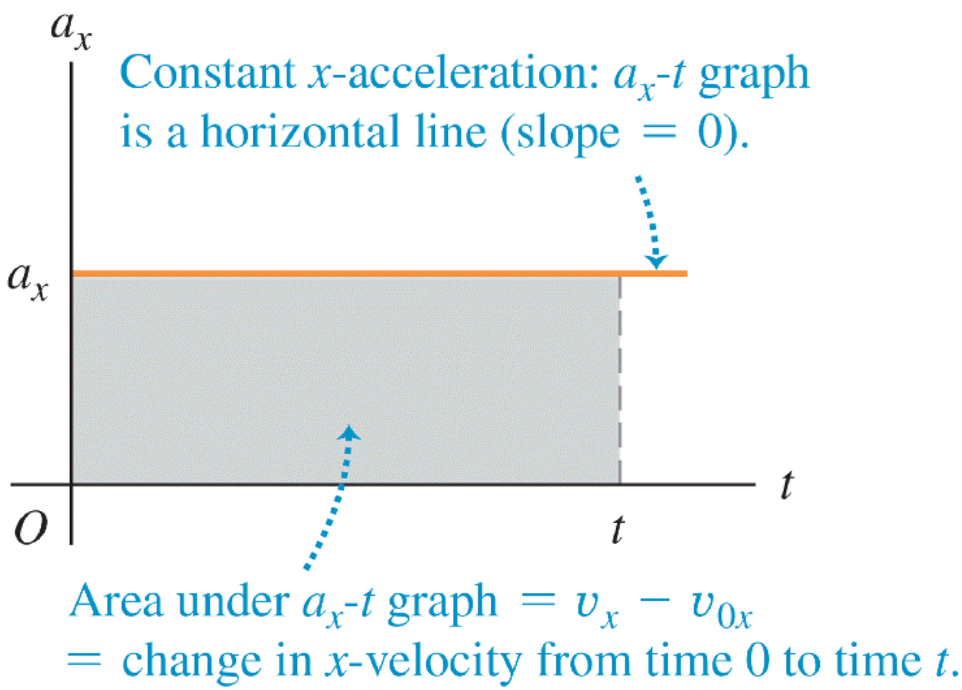
$a = \text{constant}$ & $a = \frac{dv}{dt}$ so

$$\int a\,dt = \int \frac{dv}{dt}\,dt$$

$$\Rightarrow a\int dt = \int \frac{dv}{dt}\,dt$$

But $dv = \frac{dv}{dt}\,dt$

so $a\int dt = \int dv$



Constant acceleration

$a = \text{constant}$ & $a = \frac{dv}{dt}$ So

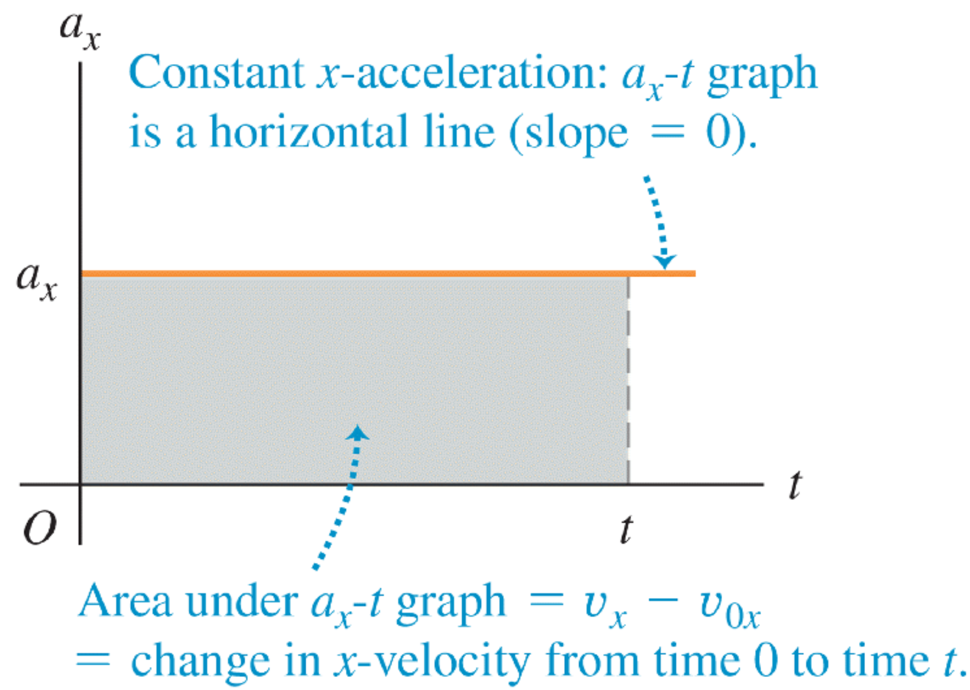
$\int a\,dt = \int \frac{dv}{dt}\,dt$

$\Rightarrow a\int dt = \int \frac{dv}{dt}\,dt$

But $dv = \frac{dv}{dt}\,dt$

So $a\int dt = \int dv$

$\Rightarrow a\Delta t = \Delta v$



Constant acceleration

$a = \text{constant}$ & $a = \frac{dv}{dt}$ so

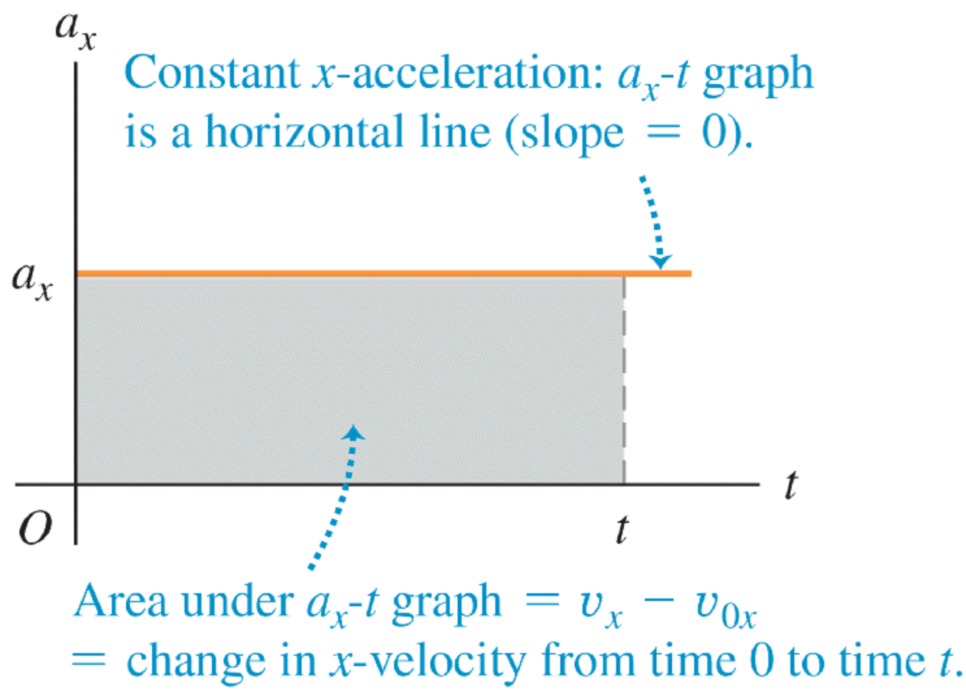
$\int a\,dt = \int \frac{dv}{dt}\,dt$

$\Rightarrow a\int dt = \int \frac{dv}{dt}\,dt$

But $dv = \frac{dv}{dt}\,dt$

so $a\int dt = \int dv$

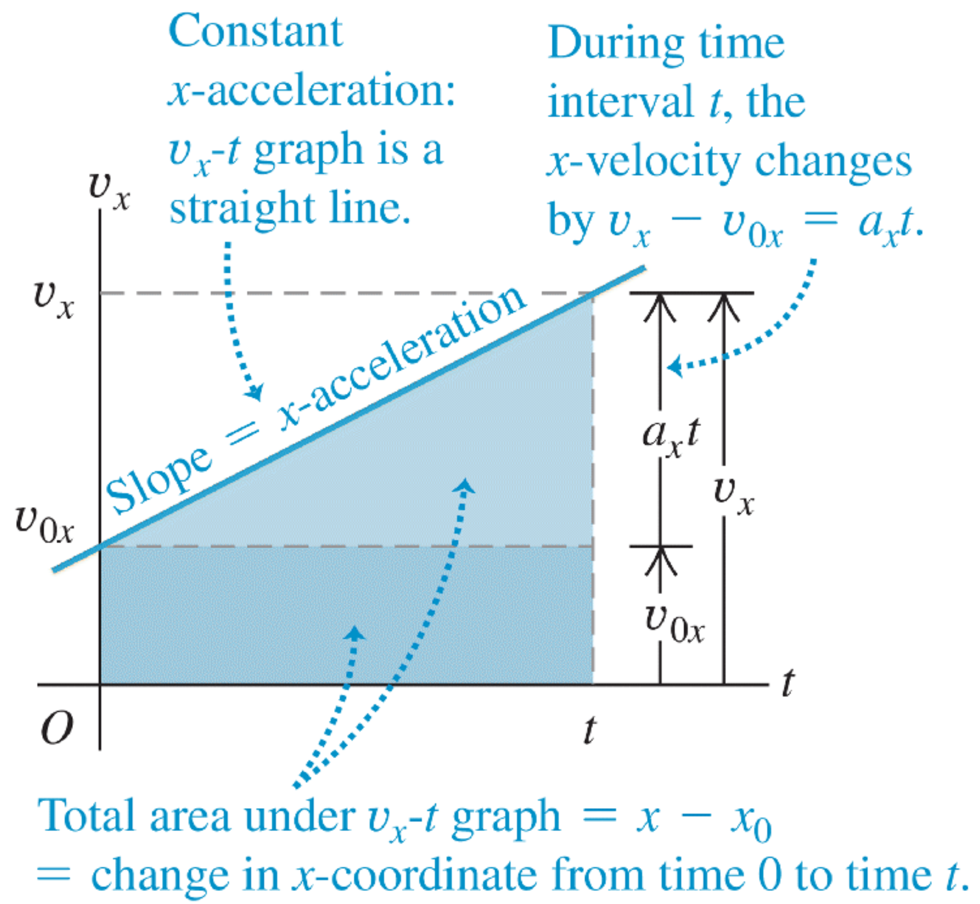
$$\Rightarrow \underbrace{a\Delta t}_{\text{Area under a vs t plot}} = \Delta V$$



Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$

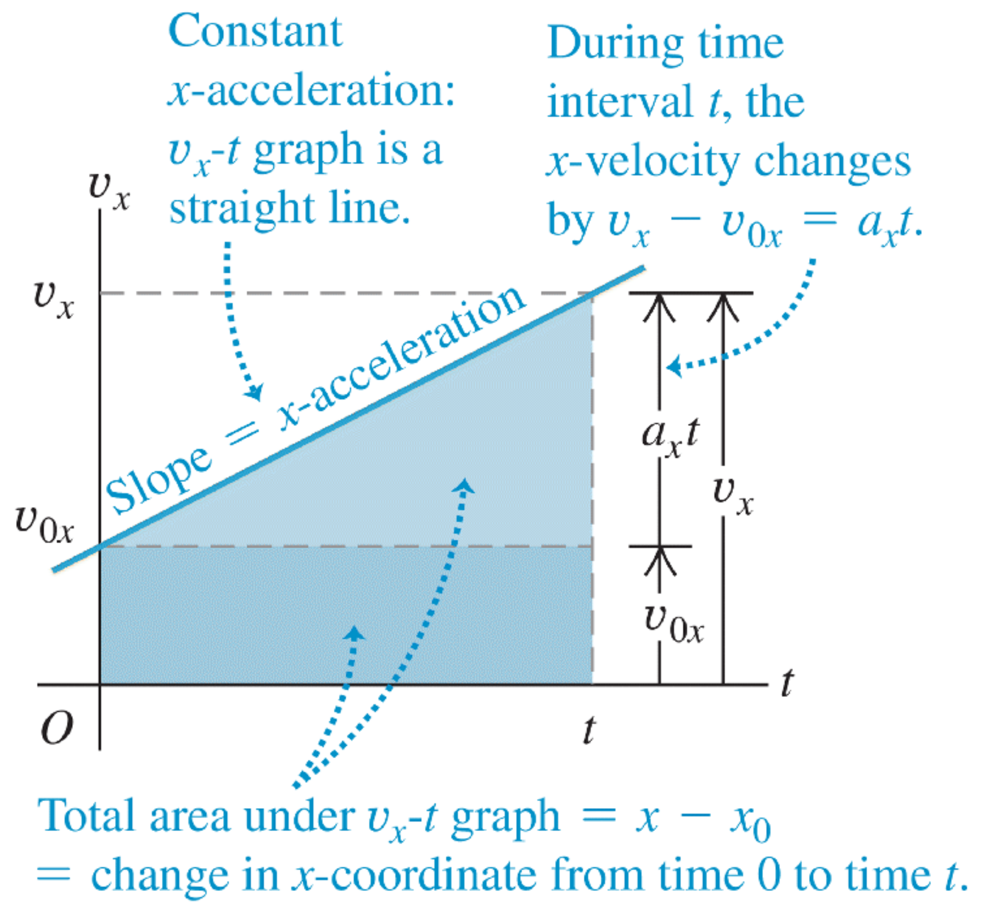


Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta v$ Let

$\Delta t = t - 0$

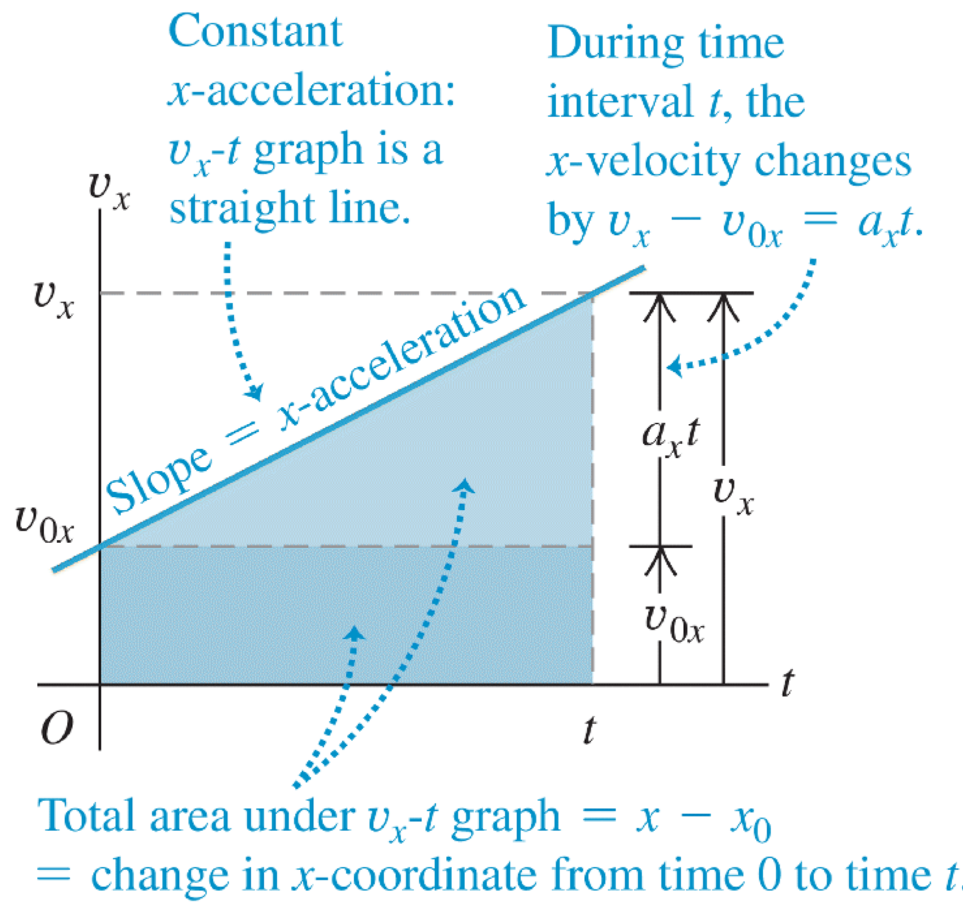


Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$ Let

$\Delta t = t - 0$ & $\Delta V = V - V_0$



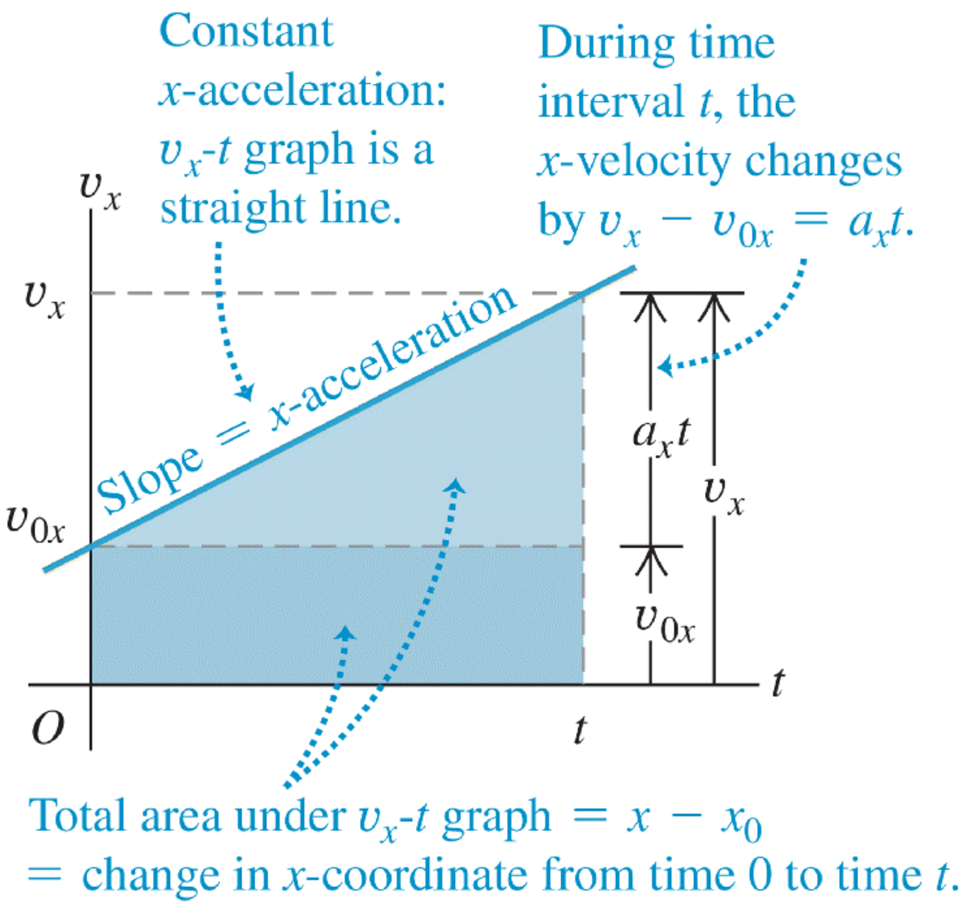
Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$ Let

$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$



Constant acceleration

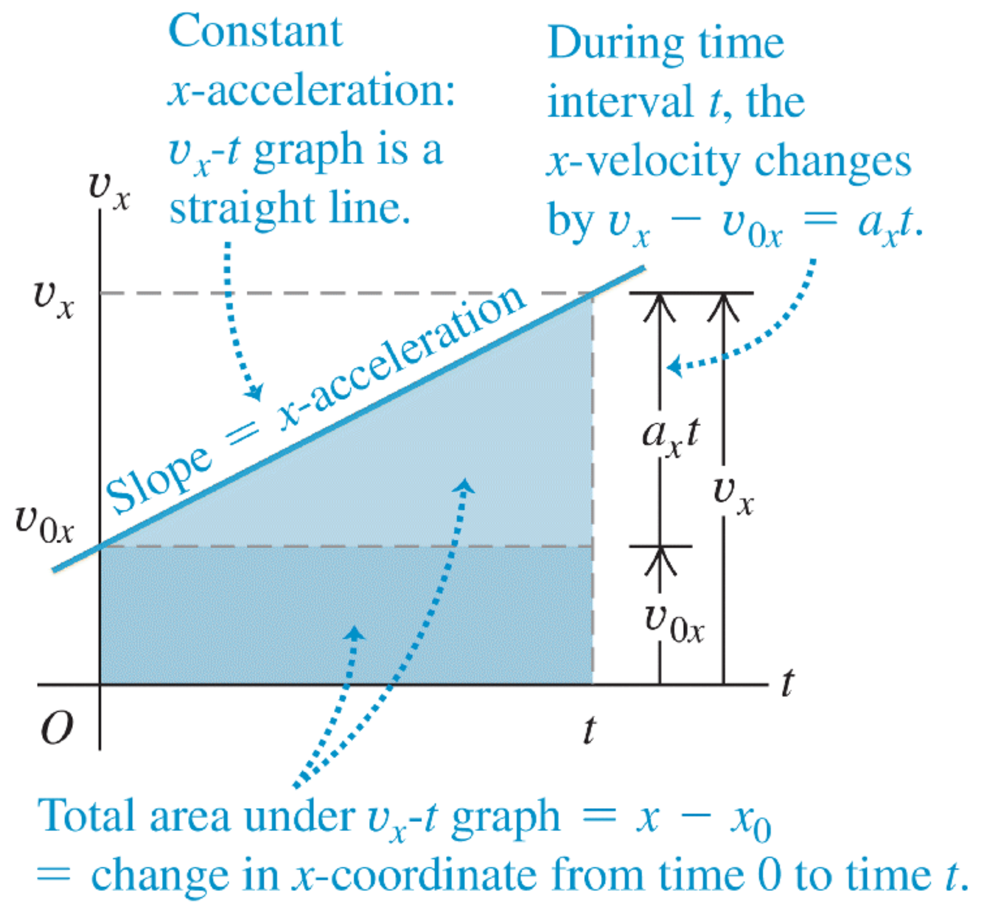
From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$ Let

$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$ or

$V = at + V_0$



Constant acceleration

From previous: If a = constant

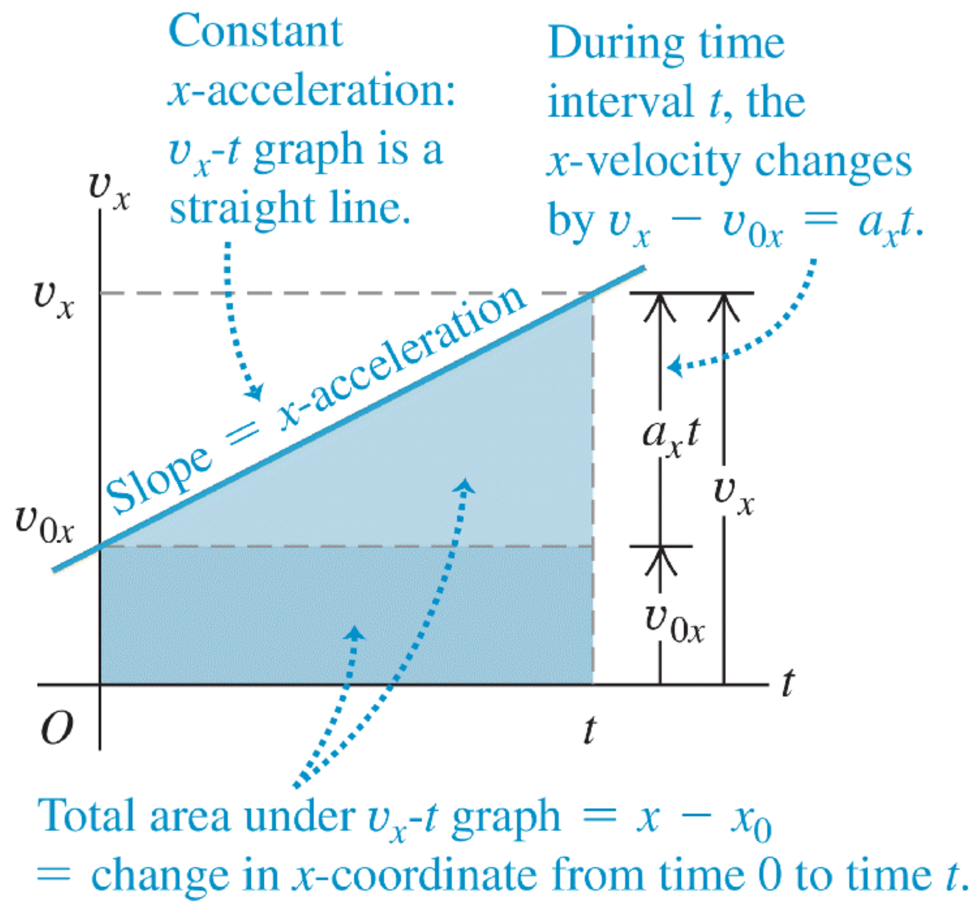
$a\Delta t = \Delta V$ Let

$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$ or

$V = at + V_0$

Equation of straight line



Constant acceleration

From previous: If $a = \text{constant}$

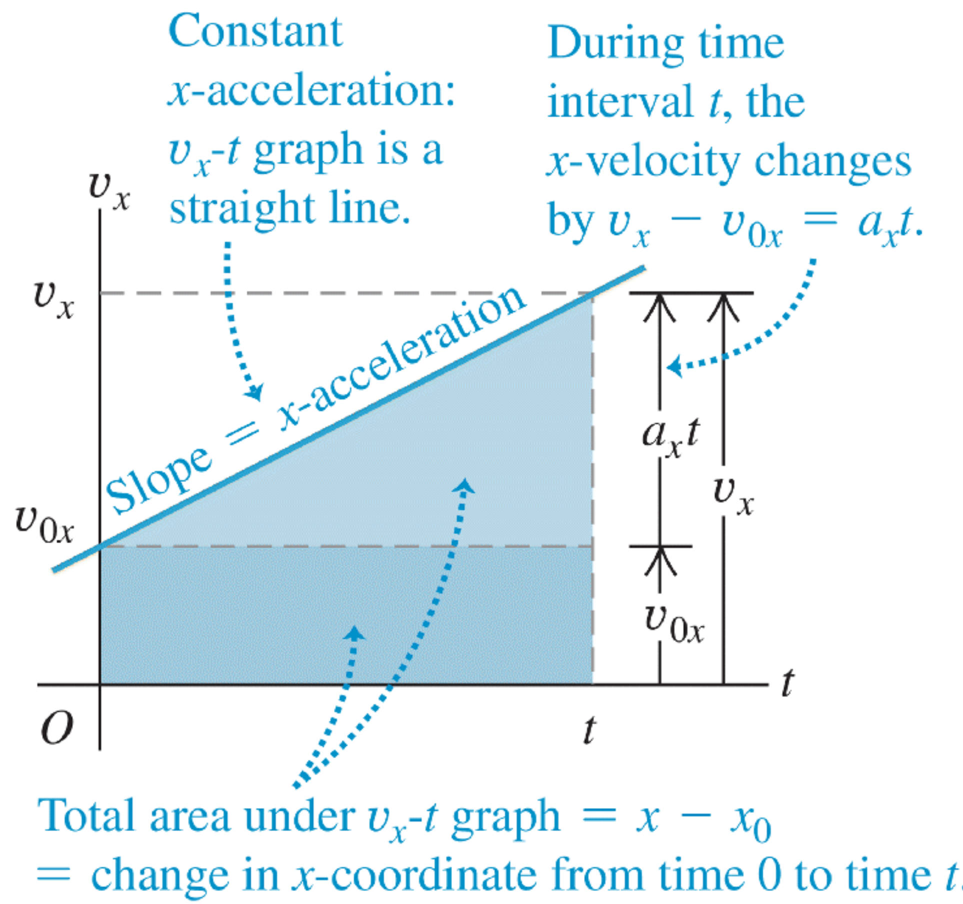
$a\Delta t = \Delta V$ Let

$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$ or

$V = at + V_0 \Rightarrow$

$\int V\,dt = \int (at + V_0)\,dt$



Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$ Let

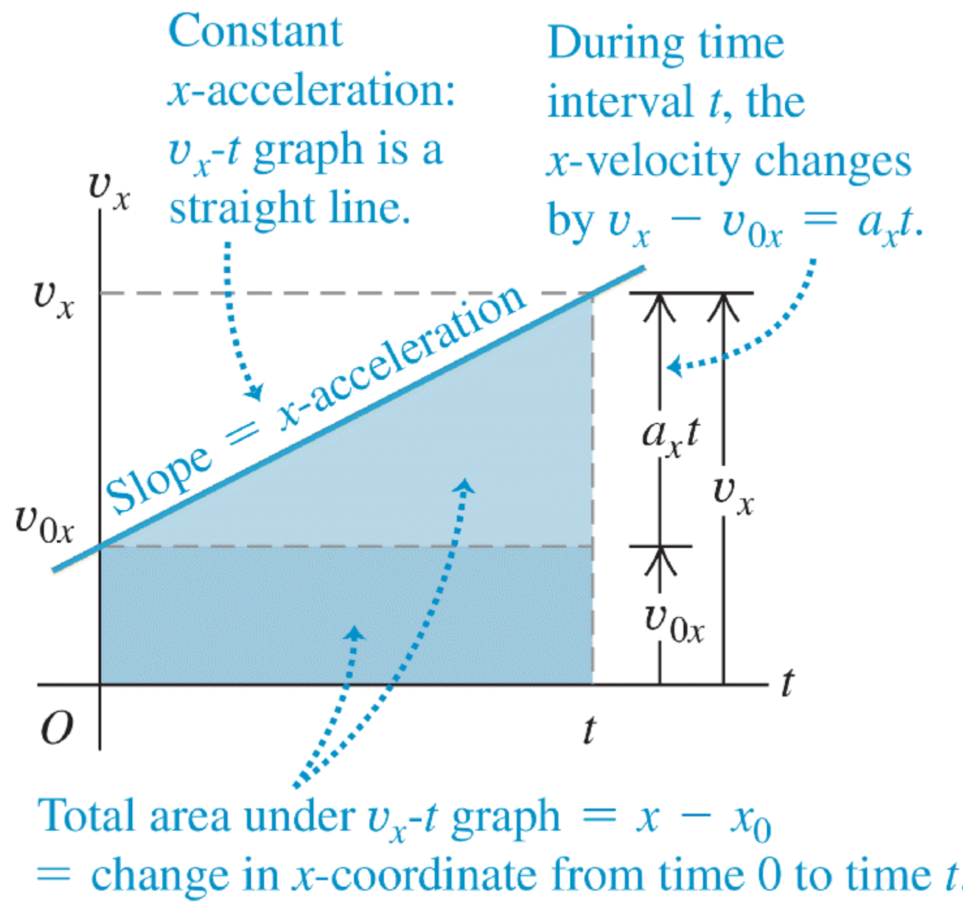
$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$ or

$V = at + V_0 \Rightarrow$

$\underbrace{\int v\,dt} = \int (at + V_0)\,dt$

Area under V vs t plot



Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$ Let

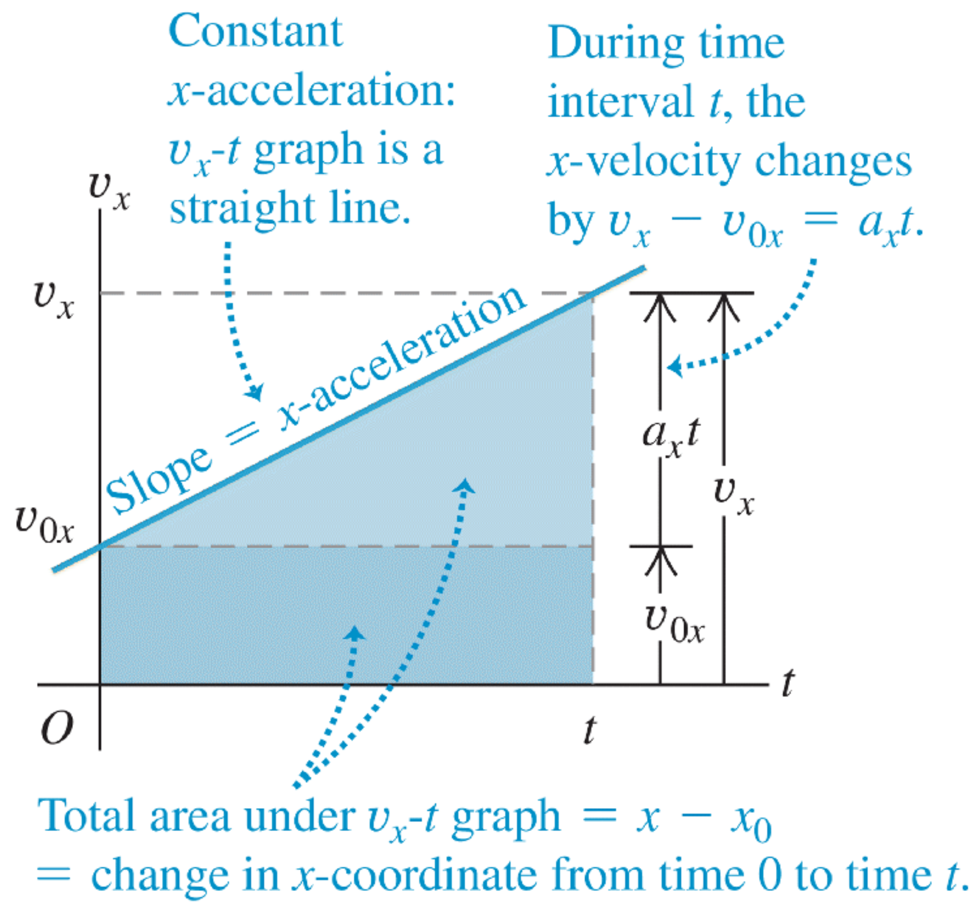
$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$ or

$V = at + V_0 \Rightarrow$

$\int V dt = \int (at + V_0) dt$

$= \frac{1}{2}at^2 +$



Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$ Let

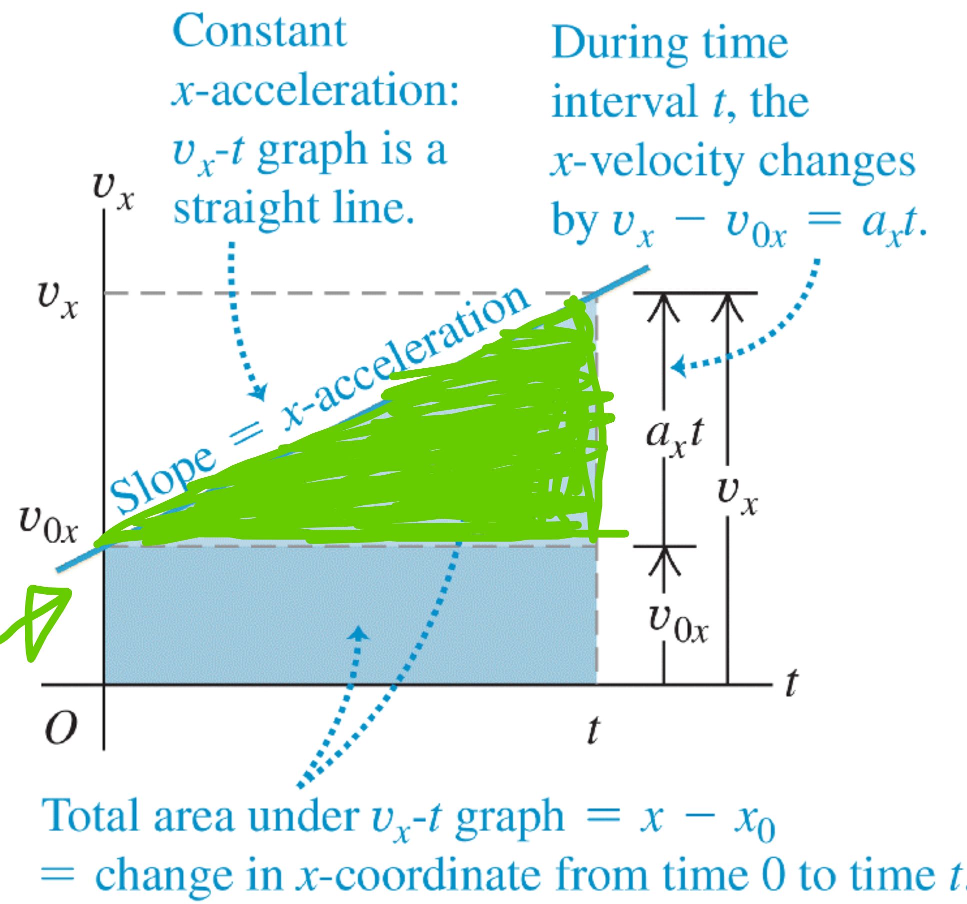
$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$ or

$V = at + V_0 \Rightarrow$

$\int V dt = \int (at + V_0) dt$

$= \underbrace{\frac{1}{2}at^2}_{\text{Area of triangle}} +$



Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta v$ Let

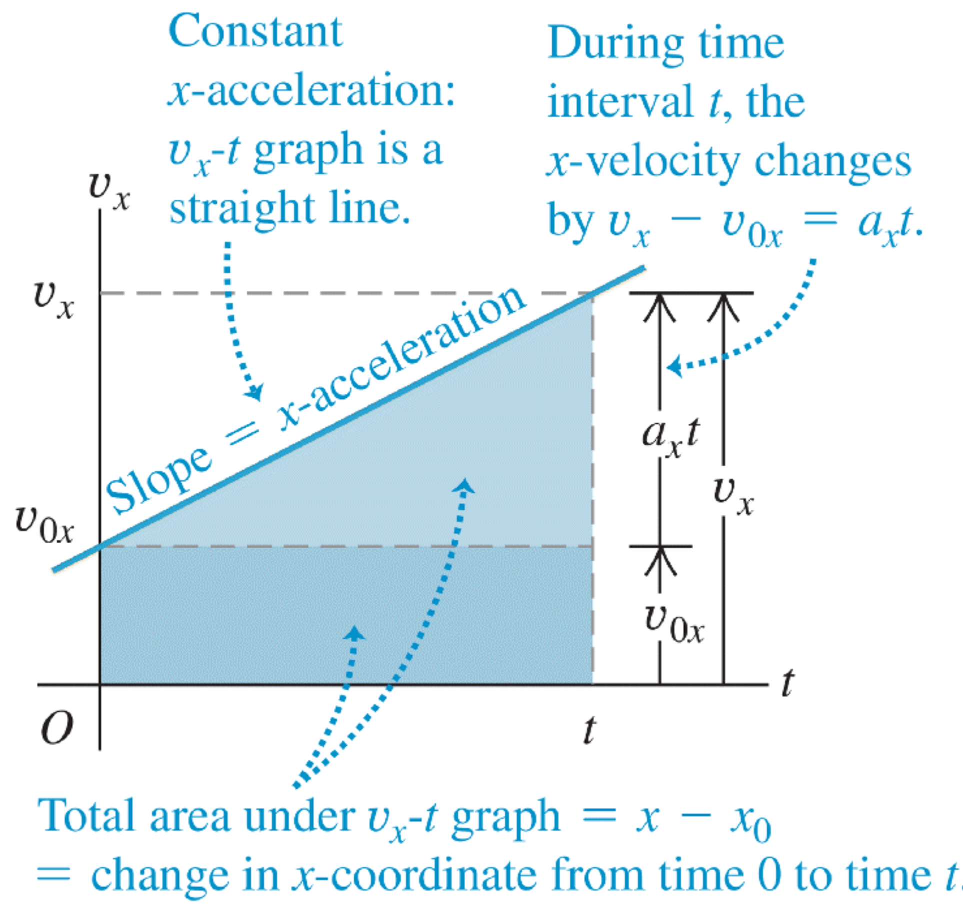
$\Delta t = t - 0$ & $\Delta v = v - v_0$

Now $at = v - v_0$ or

$v = at + v_0 \Rightarrow$

$$\int v\,dt = \int (at + v_0)\,dt$$

$$= \frac{1}{2}at^2 + v_0 t$$



Constant acceleration

From previous: If a = constant

$a\Delta t = \Delta v$ Let

$\Delta t = t - 0$ & $\Delta v = v - v_0$

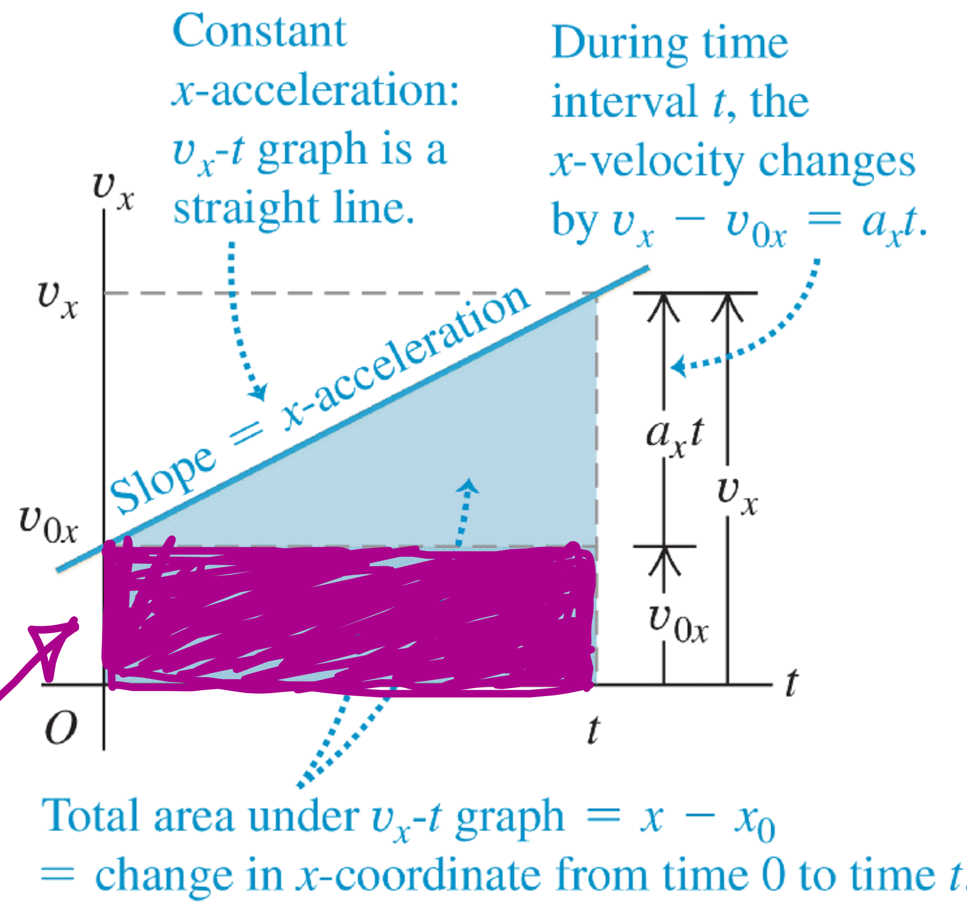
Now $at = v - v_0$ or

$v = at + v_0 \Rightarrow$

$\int v\,dt = \int (at + v_0)\,dt$

$= \frac{1}{2}at^2 + \underbrace{v_0 t}$

area of rectangle



Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$ Let

$\Delta t = t - 0$ & $\Delta V = V - V_0$

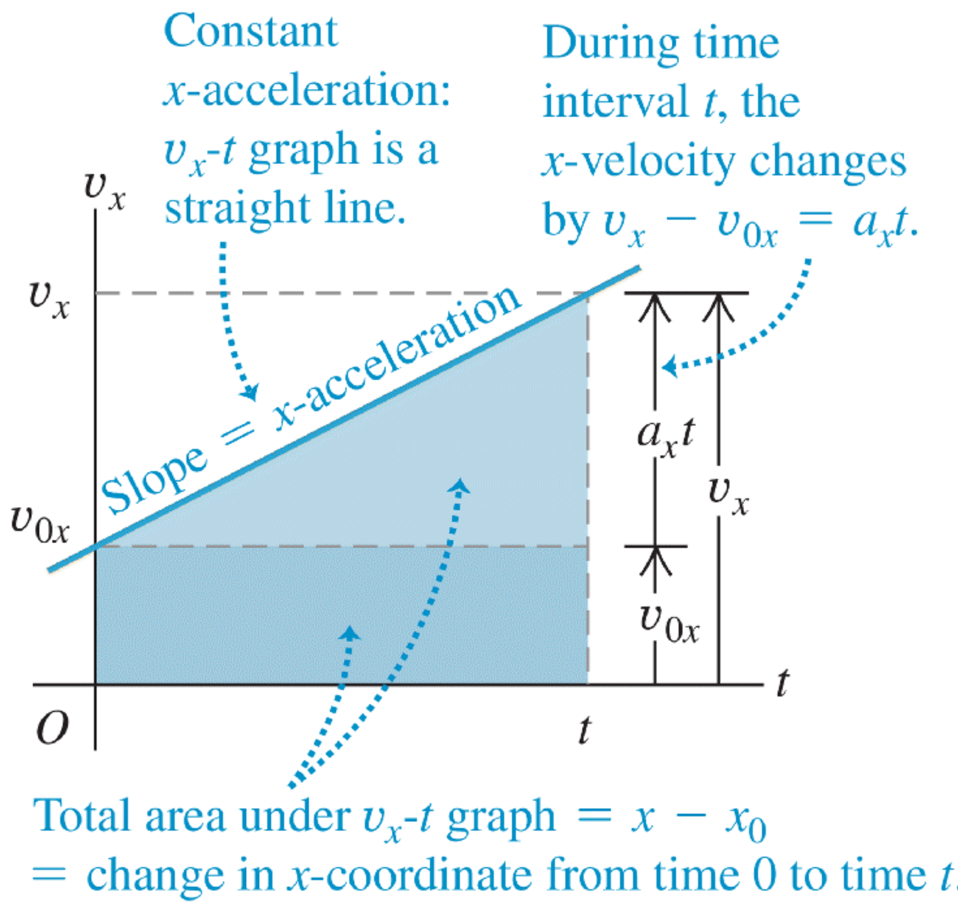
Now $at = V - V_0$ or

$V = at + V_0 \Rightarrow$

$\int V dt = \int (at + V_0) dt$

$= \frac{1}{2}at^2 + V_0 t$

But $V dt = \frac{dx}{dt} dt$



Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta V$ Let

$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$ or

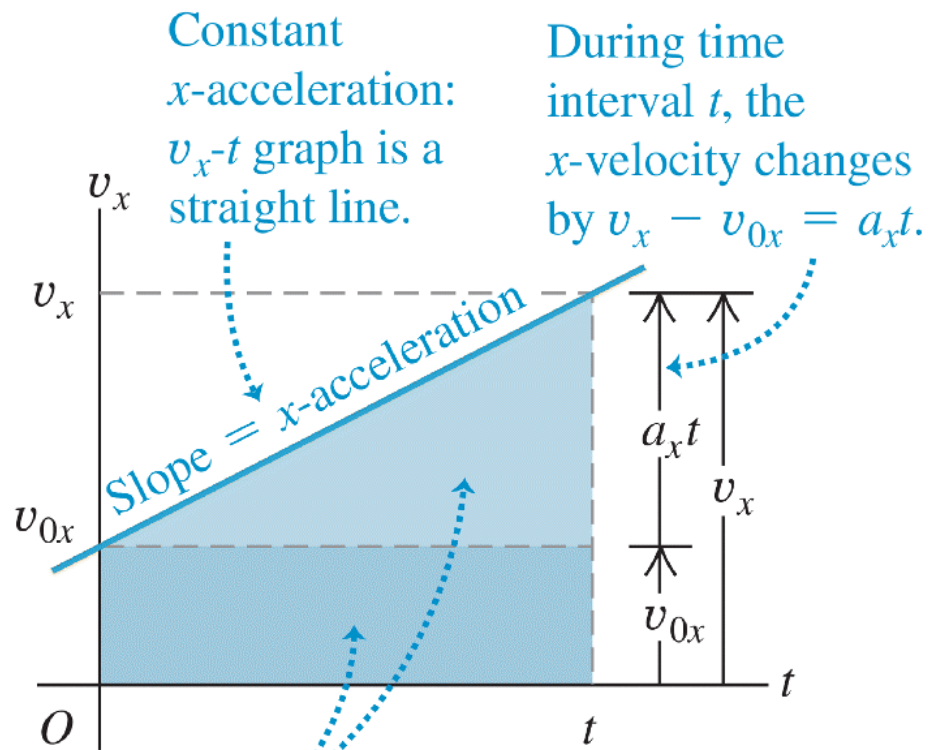
$V = at + V_0 \Rightarrow$

$\int v\,dt = \int (at + V_0)\,dt$

$= \frac{1}{2}at^2 + V_0 t$

But $v\,dt = \frac{dx}{dt}\,dt$

$= dx$



Total area under v_x-t graph $= x - x_0$
$=$ change in x-coordinate from time 0 to time t.

Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta v$ Let

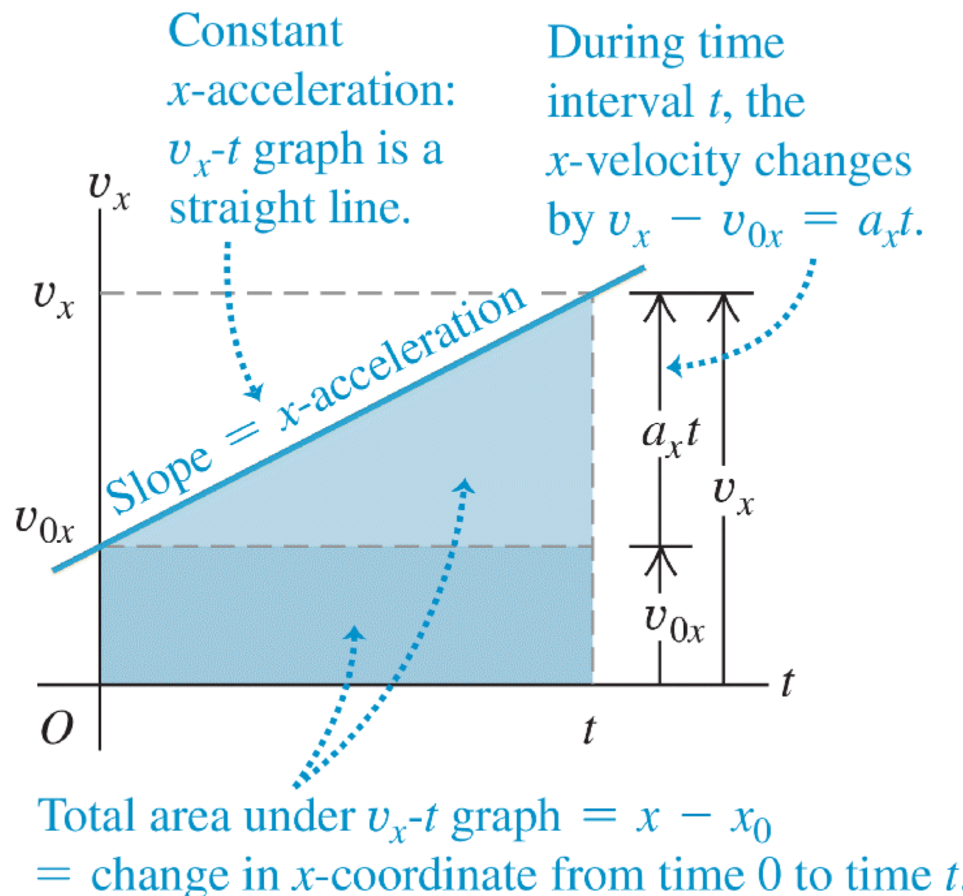
$\Delta t = t - 0$ & $\Delta v = v - v_0$

Now $at = v - v_0$ or

$v = at + v_0 \Rightarrow$

$\int v\,dt = \int (at + v_0)\,dt$

$= \frac{1}{2}at^2 + v_0 t$



But $v\,dt = \frac{dx}{dt}\,dt$

$= dx$ so $\int v\,dt = \int dx = x - x_0$

Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta v$ Let

$\Delta t = t - 0$ & $\Delta v = v - v_0$

Now $at = v - v_0$ or

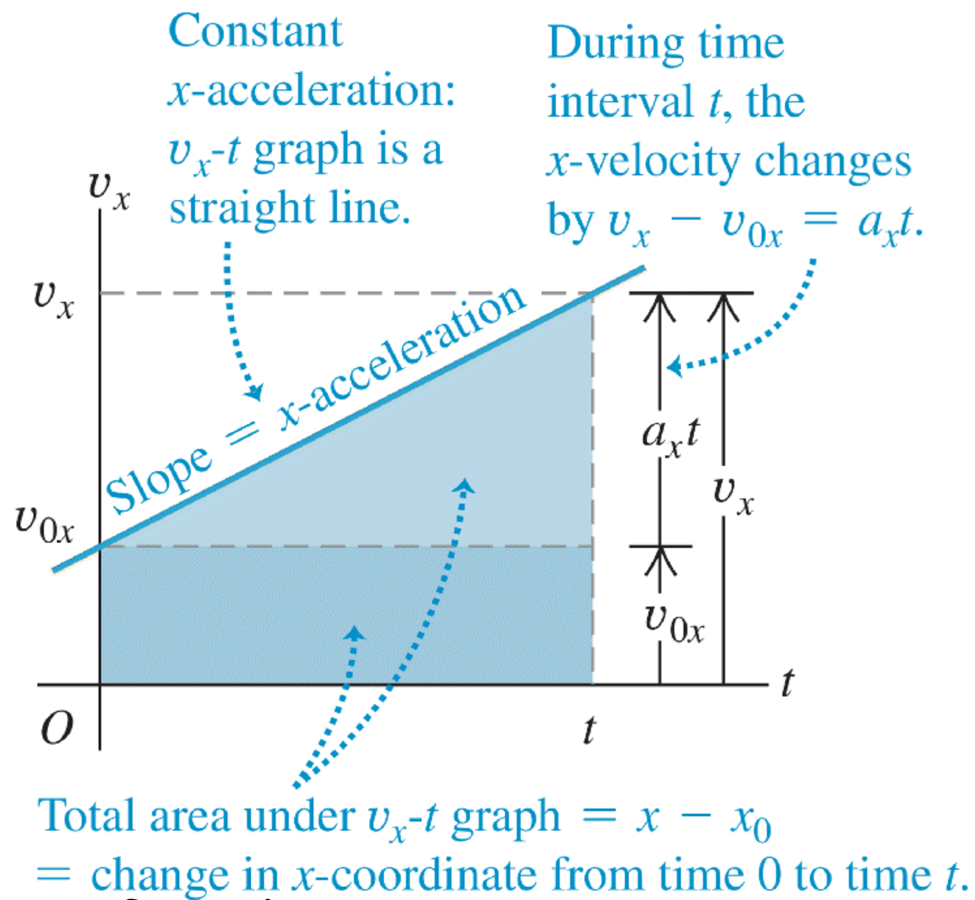
$v = at + v_0 \Rightarrow$

$$\int v\,dt = \int (at + v_0)\,dt$$

$$= \tfrac{1}{2}at^2 + v_0 t$$

But $v\,dt = \frac{dx}{dt}\,dt$

$= dx$ so $\int v\,dt = \int dx = x - x_0$



Constant acceleration

From previous: If $a = \text{constant}$

$a\Delta t = \Delta v$ Let

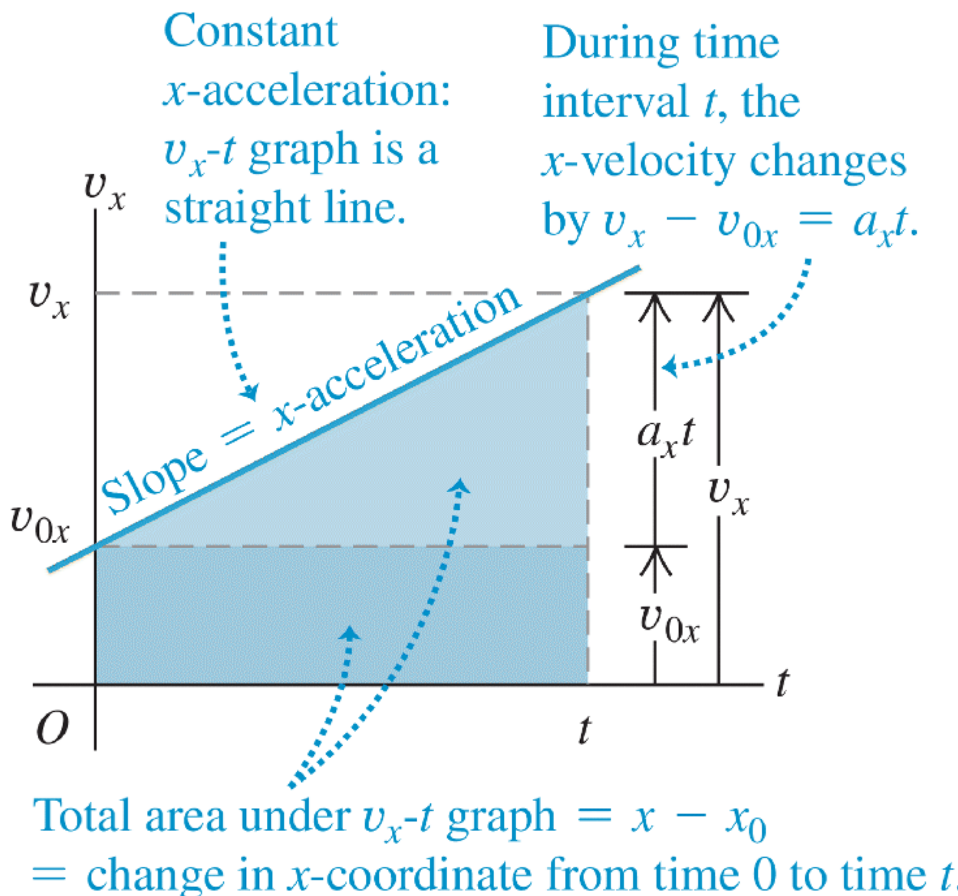
$\Delta t = t - 0$ & $\Delta v = v - v_0$

Now $at = v - v_0$ or

$v = at + v_0 \Rightarrow$

$\int v\,dt = \int (at + v_0)\,dt$

$= \frac{1}{2}at^2 + v_0 t$



But $v\,dt = \frac{dx}{dt}\,dt$

$= dx$ so $\int v\,dt = \int dx = x - x_0$

Now $x - x_0 = \frac{1}{2}at^2 + v_0 t$

Constant acceleration

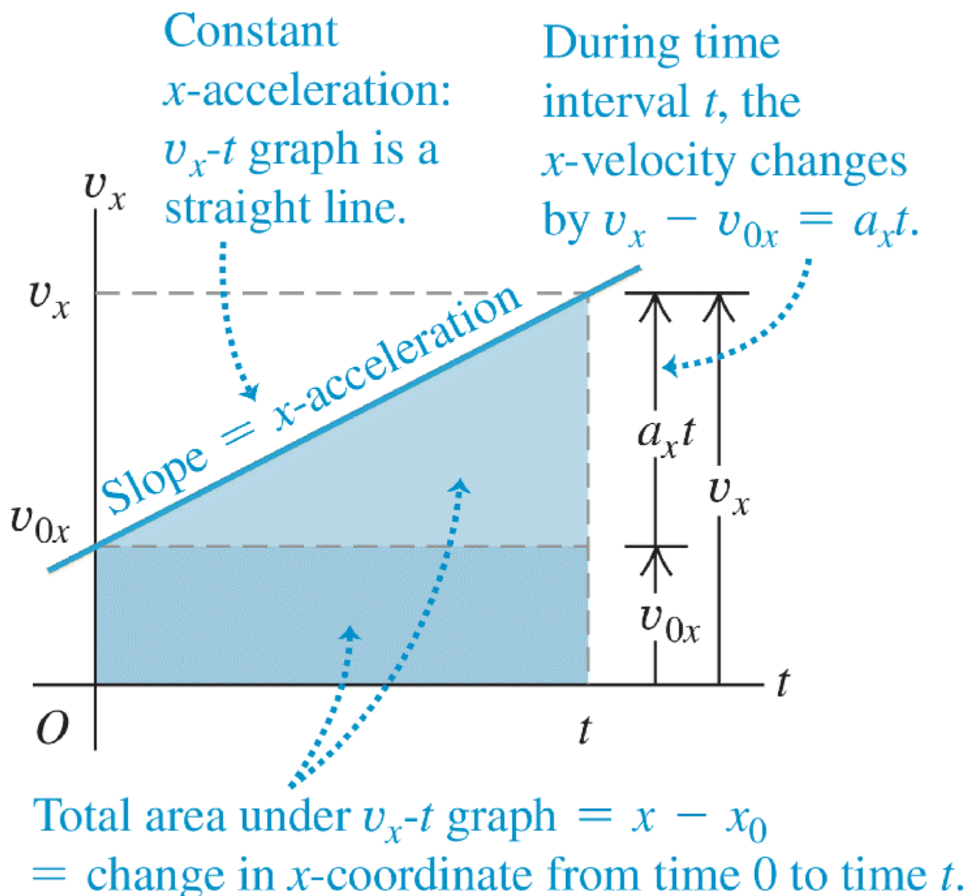
From previous: If $a = \text{constant}$

$a \Delta t = \Delta V$ Let

$\Delta t = t - 0$ & $\Delta V = V - V_0$

Now $at = V - V_0$ or

$V = at + V_0 \Rightarrow$



$$\int V dt = \int (at + V_0) dt$$

$$= \frac{1}{2}at^2 + V_0 t$$

But $V dt = \frac{dx}{dt} dt$

$= dx$ so $\int V dt = \int dx = x - x_0$

Now $x - x_0 = \frac{1}{2}at^2 + V_0 t \Rightarrow \boxed{x = \frac{1}{2}at^2 + V_0 t + x_0}$

Constant acceleration

Note $a = \frac{\partial v}{\partial t}$

Constant acceleration

Note $a = \frac{\partial v}{\partial t} = \underbrace{\left(\frac{\partial v}{\partial x}\right)\left(\frac{\partial x}{\partial t}\right)}_{\text{chain rule}}$

Constant acceleration

Note $a = \frac{\partial v}{\partial t} = \left(\frac{\partial v}{\partial x}\right)\underbrace{\left(\frac{\partial x}{\partial t}\right)}_{=\,v}$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right)v = v\frac{dv}{dx}$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$$\boxed{a = v\frac{dv}{dx}}$$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$$\boxed{a = v\frac{dv}{dx}}$$

Integrate both sides

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$\boxed{a = v\frac{dv}{dx}}$ Integrate both sides $\Rightarrow$ $a\int dx = \int v\frac{dv}{dx}dx$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$\boxed{a = v\frac{dv}{dx}}$ Integrate both sides $\Rightarrow$ $a\int dx = \int v\frac{dv}{dx}dx$

$\Rightarrow$ $a\Delta x = \int v\,dv$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$\boxed{a = v\frac{dv}{dx}}$ Integrate both sides $\Rightarrow a\int dx = \int v\frac{dv}{dx}dx$

$\Rightarrow a\Delta x = \int v\,dv \Rightarrow a\Delta x = \frac{1}{2}v^2\Big|_{v_0}^{v}$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$\boxed{a = v\frac{dv}{dx}}$ Integrate both sides $\Rightarrow a\int dx = \int v\frac{dv}{dx}dx$

$\Rightarrow a\Delta x = \int v\,dv \Rightarrow a\Delta x = \frac{1}{2}v^2\Big|_{v_0}^{v}$

$\Rightarrow a\Delta x = \frac{1}{2}(v^2 - v_0^2)$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$\boxed{a = v\frac{dv}{dx}}$ Integrate both sides $\Rightarrow a\int dx = \int v\frac{dv}{dx}dx$

$\Rightarrow a\Delta x = \int v\,dv \Rightarrow a\Delta x = \frac{1}{2}v^2\Big|_{v_0}^{v}$

$\Rightarrow a\Delta x = \frac{1}{2}(v^2 - v_0^2) \Rightarrow 2a\Delta x = v^2 - v_0^2$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$\boxed{a = v\frac{dv}{dx}}$ Integrate both sides $\Rightarrow a\int dx = \int v\frac{dv}{dx}dx$

$\Rightarrow a\Delta x = \int v\,dv \Rightarrow a\Delta x = \frac{1}{2}v^2\Big|_{v_0}^{v}$

$\Rightarrow a\Delta x = \frac{1}{2}(v^2 - v_0^2) \Rightarrow 2a\Delta x = v^2 - v_0^2$

$\Rightarrow v^2 = 2a\Delta x + v_0^2$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$\boxed{a = v\frac{dv}{dx}}$ Integrate both sides $\Rightarrow a\int dx = \int v\frac{dv}{dx}dx$

$\Rightarrow a\Delta x = \int v\,dv \Rightarrow a\Delta x = \frac{1}{2}v^2\Big|_{v_0}^{v}$

$\Rightarrow a\Delta x = \frac{1}{2}(v^2 - v_0^2) \Rightarrow 2a\Delta x = v^2 - v_0^2$

$\Rightarrow v^2 = 2a\Delta x + v_0^2 \Rightarrow \boxed{v^2 = v_0^2 + 2a(x - x_0)}$

Constant acceleration

Note $a = \frac{dv}{dt} = \left(\frac{dv}{dx}\right)\left(\frac{dx}{dt}\right) = \left(\frac{dv}{dx}\right) v = v\frac{dv}{dx}$

$\boxed{a = v\frac{dv}{dx}}$ Integrate both sides $\Rightarrow a\int dx = \int v\frac{dv}{dx}dx$

$\Rightarrow a\Delta x = \int v\,dv \Rightarrow a\Delta x = \frac{1}{2}v^2\Big|_{v_0}^{v}$

$\Rightarrow a\Delta x = \frac{1}{2}(v^2 - v_0^2) \Rightarrow 2a\Delta x = v^2 - v_0^2$

$\Rightarrow v^2 = 2a\Delta x + v_0^2 \Rightarrow \boxed{v^2 = v_0^2 + 2a(x - x_0)}$

x-velocity of the particle at time 0

x-velocity at time t of a particle with **constant x-acceleration**

$$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$$

Constant x-acceleration of the particle

Position of the particle at time t

Position of the particle at time 0

Constant acceleration

$$\underbrace{V_{ave} = \frac{\Delta x}{\Delta t}}_{\text{By deffinition}}$$

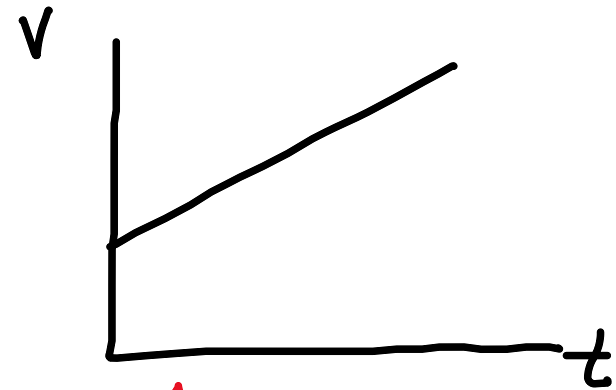
Constant acceleration

$$V_{AVE} = \frac{\Delta x}{\Delta t} = \frac{\Delta x}{t}$$

taking $\Delta t = t - \cancel{0}$

Constant acceleration

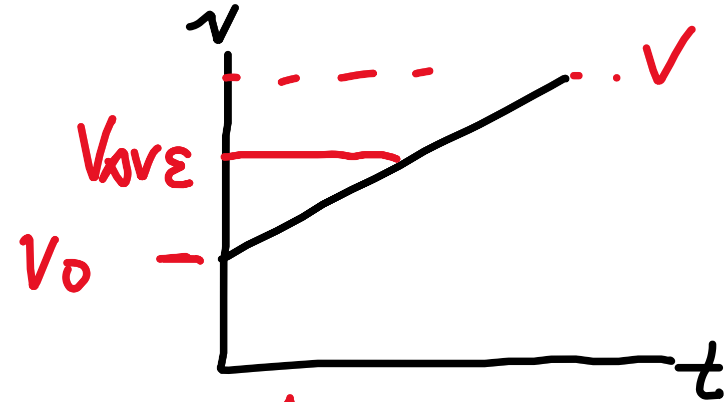
$$V_{ave} = \frac{\Delta x}{\Delta t} = \frac{\Delta x}{t}$$



plot of v vs t for constant acceleration

Constant acceleration

$$V_{ave} = \frac{\Delta x}{\Delta t} = \frac{\Delta x}{t}$$

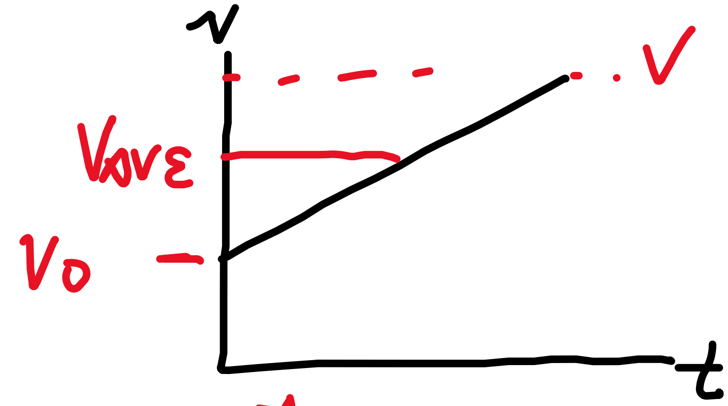


plot of V vs t for constant acceleration

Constant acceleration

$$V_{AVE} = \frac{\Delta x}{\Delta t} = \frac{\Delta x}{t}$$

$$\& \quad V_{AVE} = \frac{V + V_0}{2}$$

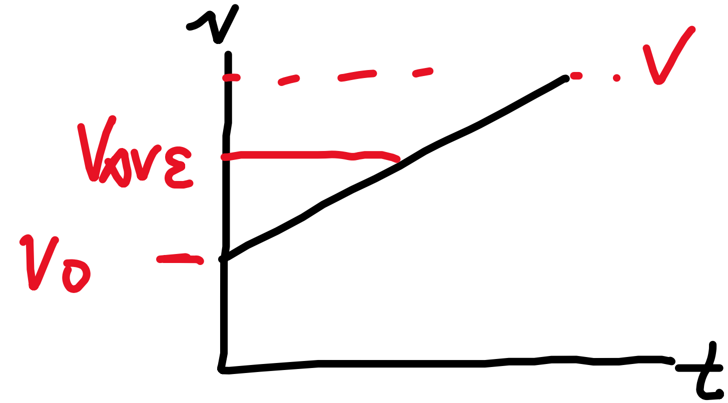


plot of V vs t for constant acceleration

Constant acceleration

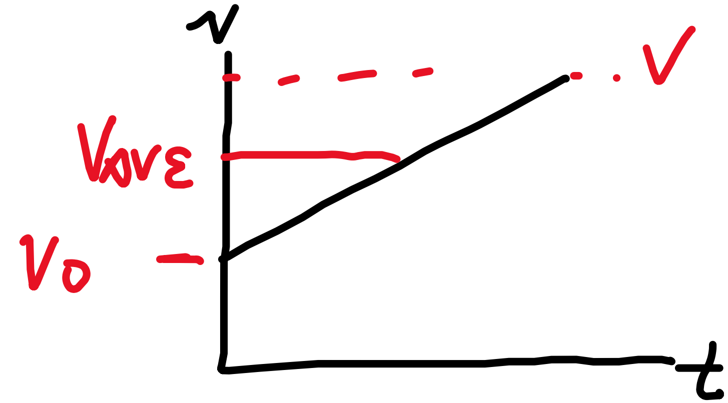
$$V_{AVE} = \frac{\Delta x}{\Delta t} = \frac{\Delta x}{t}$$

& $V_{AVE} = \frac{V + V_0}{2}$ Equate the two



Constant acceleration

$$v_{ave} = \frac{\Delta x}{\Delta t} = \frac{\Delta x}{t}$$

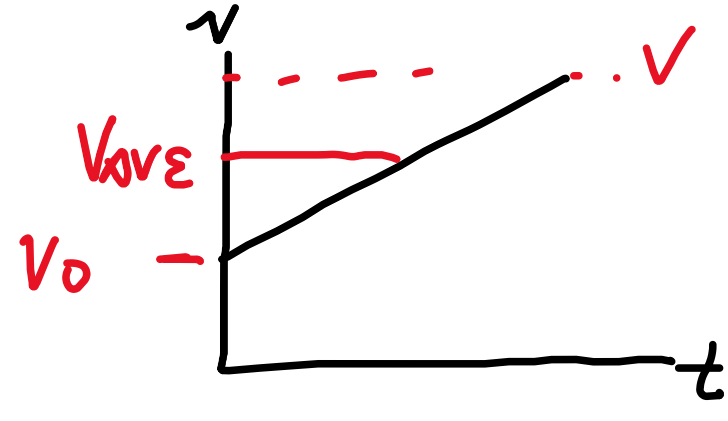


& $v_{ave} = \frac{v + v_0}{2}$ Equate the two to obtain

$$\frac{\Delta x}{t} = \frac{v + v_0}{2} \Rightarrow \Delta x = \frac{1}{2}(v + v_0)t$$

Constant acceleration

$$V_{AVE} = \frac{\Delta x}{\Delta t} = \frac{\Delta x}{t}$$



& $$V_{AVE} = \frac{V - V_0}{2}$$ Equate

the two to obtain

$$\frac{\Delta x}{t} = \frac{V + V_0}{2} \Rightarrow \Delta x = \frac{1}{2}(V + V_0)t$$

$$\Rightarrow x - x_0 = \frac{1}{2}(V_0 + V)t$$

Position at time t of a particle with **constant x-acceleration**

Position of the particle at time 0

Time

$$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$$

x-velocity of the particle at time 0

x-velocity of the particle at time t

Constant acceleration

Equation		Includes Quantities			
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x

Missing X

Constant acceleration

Equation		Includes Quantities			
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$	(2.12)	t	x		a_x

Missing V

Constant acceleration

Equation		Includes Quantities			
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x

Missing t

Constant acceleration

Equation		Includes Quantities			
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

Missing a

ASU

Constant acceleration

Equation		Includes Quantities			
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

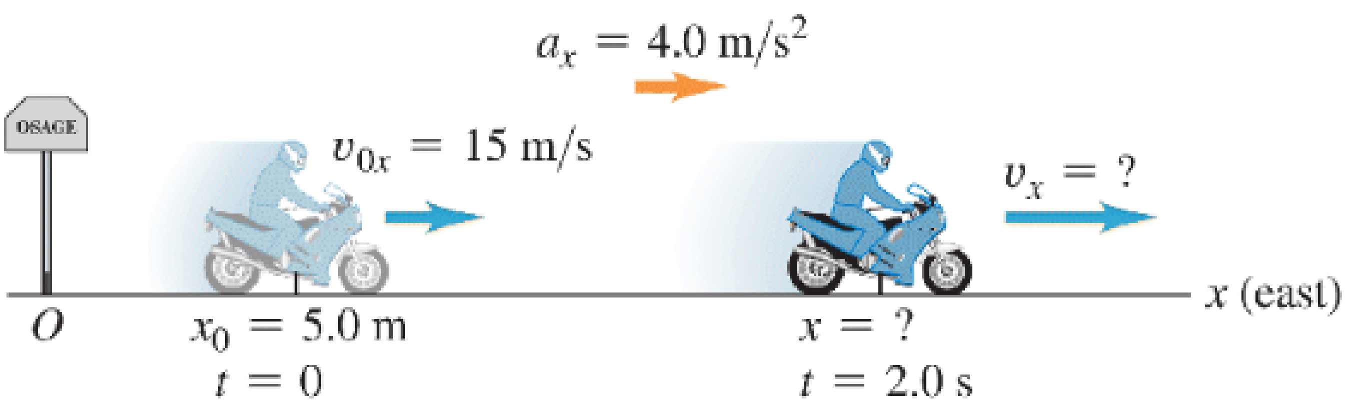
Can use this table to help decide equation to use ☺

ASU

Example 2.4 Constant-acceleration calculations

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \text{m/s}^2$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \text{m/s}$. (a) Find his position and velocity at $t = 2.0\ \text{s}$. (b) Where is he when his speed is $25\ \text{m/s}$?

Figure 2.20



A motorcyclist traveling with constant acceleration.

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}, \quad x_0 = 5.0\ \mathrm{m}$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}, \quad x_0 = 5.0\ \mathrm{m}$

ASU

A motorcyclist heading east through a small town accelerates at a constant 4.0 m/s^2 after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0 \, m/s^2, \quad x_0 = 5.0 \, m, \quad v_0 = 15 \, m/s$

A motorcyclist heading east through a small town accelerates at a constant 4.0 m/s^2 after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0 \text{ s}$. (b) Where is he when his speed is 25 m/s?

$a = 4.0 \text{ m/s}^2, \quad x_0 = 5.0 \text{ m}, \quad v_0 = 15 \text{ m/s}$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $t = 2\,\mathrm{s}$:

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $t = 2\ \mathrm{s}$:

Lets see if any of these equations will work

$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $V_0 = 15\ \mathrm{m/s}$

find x at $t = 2\ \mathrm{s}$:

2s

Equation		t	x	v_x	a_x
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $t = 2\ \mathrm{s}$:

		2s	Find		
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $t = 2\mathrm{s}$:

		2s	Find		$4\ \mathrm{m/s^2}$
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $t = 2\ \mathrm{s}$:

		2s	Find		4 m/s²
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2},\ x_0 = 5.0\ \mathrm{m},\ v_0 = 15\ \mathrm{m/s}$

find x at $t = 2\ \mathrm{s}$:

$$x = \frac{1}{2}at^2 + v_0 t + x_0$$

ASU

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $t = 2\,\mathrm{s}$:

$$x = \frac{1}{2}at^2 + v_0 t + x_0 = \frac{1}{2}\left(4\frac{\mathrm{m}}{\mathrm{s}^2}\right)(4\,\mathrm{s}^2) + (15\ \mathrm{m/s})2\,\mathrm{s} + 5\,\mathrm{m}$$

ASU

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2},\ X_0 = 5.0\ \mathrm{m},\ V_0 = 15\ \mathrm{m/s}$

find x at $t = 2s$:

$$x = \frac{1}{2}at^2 + V_0 t + X_0 = \frac{1}{2}\left(4\frac{m}{s^2}\right)(4s^2) + (15\ \mathrm{m/s})2s + 5m$$

$$\Rightarrow \quad x = 8m + 30m + 5m$$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $X_0 = 5.0\ \mathrm{m}$, $V_0 = 15\ \mathrm{m/s}$

find x at $t = 2s$:

$$x = \tfrac{1}{2}at^2 + V_0 t + X_0 = \tfrac{1}{2}\left(4\tfrac{m}{s^2}\right)(4s^2) + (15\ \mathrm{m/s})2s + 5m$$

$$\Rightarrow \quad x = 8m + 30m + 5m = 43m$$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\,\mathrm{m/s^2},\ x_0 = 5.0\,\mathrm{m},\ v_0 = 15\,\mathrm{m/s}$

find x at t = 2s:

$$x = \frac{1}{2}at^2 + v_0 t + x_0 = \frac{1}{2}\left(4\frac{\mathrm{m}}{\mathrm{s}^2}\right)(4\,\mathrm{s}^2) + (15\,\mathrm{m/s})2\,\mathrm{s} + 5\,\mathrm{m}$$

$$\Rightarrow\quad x = 8\,\mathrm{m} + 30\,\mathrm{m} + 5\,\mathrm{m} = 43\,\mathrm{m} \quad \boxed{x = 43\,\mathrm{m}}$$

A motorcyclist heading east through a small town accelerates at a constant $4.0 \mathrm{~m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15 \mathrm{~m/s}$. (a) Find his position and velocity at $t = 2.0 \mathrm{~s}$. (b) Where is he when his speed is $25 \mathrm{~m/s}$?

$a = 4.0 \,\mathrm{m/s^2}$, $x_0 = 5.0 \,\mathrm{m}$, $v_0 = 15 \,\mathrm{m/s}$

find v at $t = 2s$:

$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x (x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x) t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $V_0 = 15\ \mathrm{m/s}$

find V at $t = 2s$:

2s

$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ m/s^2$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\ m/s^2$, $x_0 = 5.0\ m$, $v_0 = 15\ m/s$

find v at $t = 2s$:

2s

$4\ m/s^2$

$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $V_0 = 15\ \mathrm{m/s}$

find V at $t = 2\ \mathrm{s}$:

		2s		find	$4\ \mathrm{m/s^2}$
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $V_0 = 15\ \mathrm{m/s}$

find V at $t = 2\ \mathrm{s}$:

		2s		find	$4\ \mathrm{m/s^2}$
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find v at $t = 2\,\mathrm{s}$: $v = at + v_0$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ m/s^2$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ m/s$. (a) Find his position and velocity at $t = 2.0\ s$. (b) Where is he when his speed is $25\ m/s$?

$a = 4.0\ m/s^2,\quad x_0 = 5.0\ m,\quad v_0 = 15\ m/s$

find v at $t = 2s$: $\quad v = at + v_0$

$\Rightarrow \quad v = (4\ \frac{m}{s^2})\,2s + 15\ m/s$

A motorcyclist heading east through a small town accelerates at a constant 4.0 m/s^2 after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0 \text{ s}$. (b) Where is he when his speed is 25 m/s?

$a = 4.0 \, \text{m/s}^2, \; x_0 = 5.0 \, \text{m}, \; v_0 = 15 \, \text{m/s}$

find v at t = 2s: $v = at + v_0$

$\Rightarrow \; v = \left(4 \frac{\text{m}}{\text{s}^2}\right) 2\text{s} + 15 \, \text{m/s} = 8 \, \text{m/s} + 15 \, \text{m/s}$

ASU

A motorcyclist heading east through a small town accelerates at a constant 4.0 m/s^2 after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0 \text{ s}$. (b) Where is he when his speed is 25 m/s?

$a = 4.0 \, \text{m/s}^2, \quad x_0 = 5.0 \, \text{m}, \quad v_0 = 15 \, \text{m/s}$

<u>find v at t = 2s</u>: $v = at + v_0$

$\Rightarrow \quad v = \left(4 \frac{\text{m}}{\text{s}^2}\right) 2\text{s} + 15 \, \text{m/s} = 8 \, \text{m/s} + 15 \, \text{m/s} = 23 \, \text{m/s}$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\,\mathrm{m/s^2}, \quad x_0 = 5.0\,\mathrm{m}, \quad V_0 = 15\,\mathrm{m/s}$

find V at $t = 2s$: $V = at + V_0$

$\Rightarrow \quad V = \left(4\,\frac{\mathrm{m}}{\mathrm{s}^2}\right) 2s + 15\,\mathrm{m/s} = 8\,\mathrm{m/s} + 15\,\mathrm{m/s} = 23\,\mathrm{m/s}$

$\boxed{V = 23\,\mathrm{m/s}}$

A motorcyclist heading east through a small town accelerates at a constant 4.0 m/s^2 after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0 \text{ m/s}^2$, $x_0 = 5.0 \text{ m}$, $v_0 = 15 \text{ m/s}$

find x at $v = 25 \text{ m/s}$:

$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $V_0 = 15\ \mathrm{m/s}$

find x at $V = 25\ \mathrm{m/s}$:

25 m/s

$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $v = 25\ \mathrm{m/s}$?

				$25\ \mathrm{m/s}$	$4\ \mathrm{m/s^2}$
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $v = 25\ \mathrm{m/s}$!

find 25 m/s 4 m/s²

$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$	(2.12)	t	x		a_x
$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant 4.0 m/s^2 after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\,m/s^2$, $x_0 = 5.0\,m$, $v_0 = 15\,m/s$

find x at $v = 25\,m/s$?

				find x	25 m/s	4 m/s²
$v_x = v_{0x} + a_x t$	(2.8)	t		v_x	a_x
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$	(2.12)	t	x		a_x
$\boxed{v_x^2 = v_{0x}^2 + 2a_x(x - x_0)}$	(2.13)		x	v_x	a_x
$x - x_0 = \frac{1}{2}(v_{0x} + v_x)t$	(2.14)	t	x	v_x	

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}$, $x_0 = 5.0\ \mathrm{m}$, $v_0 = 15\ \mathrm{m/s}$

find x at $v = 25\ \mathrm{m/s}$: $v^2 = v_0^2 + 2a(x - x_0)$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}, \quad x_0 = 5.0\ \mathrm{m}, \quad v_0 = 15\ \mathrm{m/s}$

find x at $v = 25\ \mathrm{m/s}$: $\quad v^2 = v_0^2 + 2a(x - x_0)$

$$\Rightarrow \quad 2a(x - x_0) = v^2 - v_0^2$$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$a = 4.0\ \mathrm{m/s^2}, \quad x_0 = 5.0\ \mathrm{m}, \quad v_0 = 15\ \mathrm{m/s}$

find x at $v = 25\ \mathrm{m/s}$: $v^2 = v_0^2 + 2a(x - x_0)$

$$\Rightarrow \quad 2a(x - x_0) = v^2 - v_0^2 \Rightarrow x - x_0 = \frac{(v^2 - v_0^2)}{2a}$$

A motorcyclist heading east through a small town accelerates at a constant 4.0 m/s^2 after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0 \text{ m/s}^2, \; x_0 = 5.0 \text{ m}, \; v_0 = 15 \text{ m/s}$

find x at $v = 25 \text{ m/s}$: $v^2 = v_0^2 + 2a(x - x_0)$

$$\Rightarrow 2a(x - x_0) = v^2 - v_0^2 \Rightarrow x - x_0 = \frac{(v^2 - v_0^2)}{2a}$$

$$\Rightarrow x = \frac{(v^2 - v_0^2)}{2a} + x_0$$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$$a = 4.0\,\mathrm{m/s^2},\quad x_0 = 5.0\,\mathrm{m},\quad v_0 = 15\,\mathrm{m/s}$$

find x at $v = 25\,\mathrm{m/s}$: $v^2 = v_0^2 + 2a(x - x_0)$

$$\Rightarrow\ 2a(x - x_0) = v^2 - v_0^2 \ \Rightarrow\ x - x_0 = \frac{(v^2 - v_0^2)}{2a}$$

$$\Rightarrow\ x = \frac{(v^2 - v_0^2)}{2a} + x_0 = \left[\frac{25^2 - 15^2}{2 * 4}\right]\mathrm{m} + 5\,\mathrm{m}$$

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\ \mathrm{m/s^2},\ x_0 = 5.0\ \mathrm{m},\ v_0 = 15\ \mathrm{m/s}$

find x at $v = 25\ \mathrm{m/s}$: $v^2 = v_0^2 + 2a(x - x_0)$

$$\Rightarrow\ 2a(x-x_0) = v^2 - v_0^2 \Rightarrow x - x_0 = \frac{(v^2 - v_0^2)}{2a}$$

$$\Rightarrow\ x = \frac{(v^2 - v_0^2)}{2a} + x_0 = \left[\frac{25^2 - 15^2}{2 * 4}\right] m + 5 m$$

Put into calculator

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at $15\ \mathrm{m/s}$. (a) Find his position and velocity at $t = 2.0\ \mathrm{s}$. (b) Where is he when his speed is $25\ \mathrm{m/s}$?

$$a = 4.0\ \mathrm{m/s^2},\quad x_0 = 5.0\ \mathrm{m},\quad V_0 = 15\ \mathrm{m/s}$$

find x at V = 25 m/s: $V^2 = V_0^2 + 2a(x - x_0)$

$$\Rightarrow\ 2a(x - x_0) = V^2 - V_0^2 \Rightarrow x - x_0 = \frac{(V^2 - V_0^2)}{2a}$$

$$\Rightarrow\ x = \frac{(V^2 - V_0^2)}{2a} + x_0 = \left[\frac{25^2 - 15^2}{2 * 4}\right]\mathrm{m} + 5\mathrm{m} = 55\mathrm{m}$$

ASU

A motorcyclist heading east through a small town accelerates at a constant $4.0\ \mathrm{m/s^2}$ after he leaves the city limits (Fig. 2.20). At time $t = 0$ he is 5.0 m east of the city-limits signpost while he moves east at 15 m/s. (a) Find his position and velocity at $t = 2.0$ s. (b) Where is he when his speed is 25 m/s?

$a = 4.0\ \mathrm{m/s^2},\ x_0 = 5.0\ \mathrm{m},\ v_0 = 15\ \mathrm{m/s}$

find x at v = 25 m/s: $v^2 = v_0^2 + 2a(x - x_0)$

$\Rightarrow\ 2a(x - x_0) = v^2 - v_0^2 \Rightarrow x - x_0 = \frac{(v^2 - v_0^2)}{2a}$

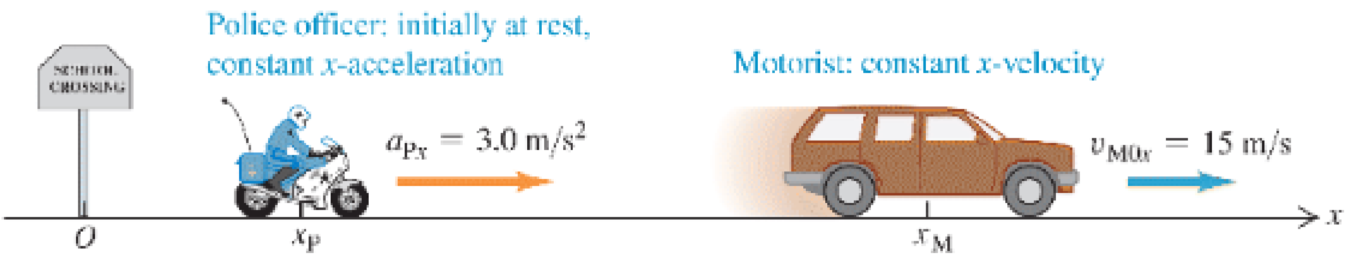
$\Rightarrow\ x = \frac{(v^2 - v_0^2)}{2a} + x_0 = \left[\frac{25^2 - 15^2}{2*4}\right]\mathrm{m} + 5\mathrm{m} = 55\mathrm{m}$

so $\boxed{x = 55\ \mathrm{m}}$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \mathrm{m/s^2}$ (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Figure 2.21

(a)



A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \mathrm{m/s^2}$ (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ m/s^2$ (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

ASU

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ m/s^2$ (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $\underbrace{x_{mo}}_{\text{motorist at crossing}} = x_{po} = 0$

motorist at crossing

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = \underbrace{x_{po}}_{\text{police officer}} = 0$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15 \text{ m/s}$ [constant]

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \mathrm{m/s^2}$ (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\ \mathrm{m/s}$ [constant]

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ m/s^2$ (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\ m/s$ [constant], speed limit $10\ m/s$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\,m/s$ [constant], speed limit $10\,m/s$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\,\text{m/s}$ [constant], speed limit $10\,\text{m/s}$

$a_p = 3.0\,\text{m/s}^2$ [constant]

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ m/s^2$ (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\ m/s$ [constant], speed limit $10\ m/s$

$a_p = 3.0\ m/s^2$ [constant]

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \text{m/s}^2$ (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$v_m = 15\ \text{m/s}$ [constant], speed limit 10 m/s

$a_p = 3.0\ \text{m/s}^2$ [constant], Find t when

$x_p = x_m$:

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s² (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,m/s$ [constant], speed limit $10\,m/s$

$a_p = 3.0\,m/s^2$ [constant], Find t when

$x_p = x_m$: $\quad x_p = \frac{1}{2}a_p t^2 + V_{op} + x_{po}$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,m/s$ [constant], speed limit 10 m/s

$a_p = 3.0\,m/s^2$ [constant], Find t when

$x_p = x_m$: $\quad x_p = \frac{1}{2}a_p t^2 + V_{op} + x_{po}$ &

$x_m = V_m t + x_{mo}$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$v_m = 15\,\text{m/s}$ [constant], speed limit $10\,\text{m/s}$

$a_p = 3.0\,\text{m/s}^2$ [constant], Find t when

$x_p = x_m$: $\quad x_p = \frac{1}{2}a_p t^2 + \underbrace{\cancel{v_{0p}}}_{0} + \underbrace{\cancel{x_{p0}}}_{0}$ &

$x_m = v_m t + \underbrace{\cancel{x_{m0}}}_{0}$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,m/s$ [constant], speed limit $10\,m/s$

$a_p = 3.0\,m/s^2$ [constant], Find t when

$x_p = x_m$: $\quad x_p = \frac{1}{2}a_p t^2 + \cancelto{0}{V_{op}} + \cancelto{0}{x_{po}}$ &

$x_m = V_m t + \cancelto{0}{x_{mo}}$ So setting $x_p = x_m$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,m/s$ [constant], speed limit $10\,m/s$

$a_p = 3.0\,m/s^2$ [constant], Find t when

$x_p = x_m$: $\quad x_p = \frac{1}{2}a_p t^2 + \cancel{V_{op}} + \cancel{x_{po}}$ &

$\phantom{x_p = x_m: \quad x_p = \frac{1}{2}a_p t^2 +}\ 0 \quad\ \ 0$

$x_m = V_m t + \cancel{x_{mo}}$ So setting $x_p = x_m \Rightarrow$

$\ 0$

$\frac{1}{2}a_p t^2 = V_m t$

ASU

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,\text{m/s}$ [constant], speed limit $10\,\text{m/s}$

$a_p = 3.0\,\text{m/s}^2$ [constant], Find t when

$x_p = x_m$: $\quad x_p = \frac{1}{2}a_p t^2 + \cancel{V_{op}}^{\,0} + \cancel{x_{po}}^{\,0}$ &

$x_m = V_m t + \cancel{x_{mo}}^{\,0}$ So setting $x_p = x_m \Rightarrow$

$$\frac{1}{2}a_p t^2 = V_m t \Rightarrow \quad t = \frac{2V_m}{a_p}$$

ASU

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,m/s$ [constant], speed limit $10\,m/s$

$a_p = 3.0\,m/s^2$ [constant], Find t when

$x_p = x_m$: $\quad x_p = \frac{1}{2}a_p t^2 + \cancel{V_{op}}^{\,0} + \cancel{x_{po}}^{\,0}$ &

$x_m = V_m t + \cancel{x_{mo}}^{\,0}$ So setting $x_p = x_m \Rightarrow$

$\frac{1}{2}a_p t^2 = V_m t \Rightarrow \quad t = \frac{2V_m}{a_p} = \frac{30\,m/s}{3\,m/s^2} = 10\,s$

ASU

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ m/s^2$ (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,m/s$ [constant], speed limit $10\,m/s$

$a_p = 3.0\,m/s^2$ [constant], Find t when

$x_p = x_m$: $\quad x_p = \frac{1}{2}a_p t^2 + \cancel{V_{op}} + \cancel{x_{po}}$ &

$x_m = V_m t + \cancel{x_{mo}}$ So setting $x_p = x_m \Rightarrow$

$\frac{1}{2}a_p t^2 = V_m t \Rightarrow t = \frac{2V_m}{a_p} = \frac{30\,m/s}{3\,m/s^2} = 10\,s$

$\Rightarrow \boxed{t = 10\,s}$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \mathrm{m/s^2}$ (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\ \mathrm{m/s}$ [constant], speed limit $10\ \mathrm{m/s}$

$a_p = 3.0\ \mathrm{m/s^2}$ [constant]

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$v_m = 15\,\text{m/s}$ [constant], speed limit $10\,\text{m/s}$

$a_p = 3.0\,\text{m/s}^2$ [constant], find $v_p(t=10\,\text{s})$:

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \mathrm{m/s^2}$ (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\ \mathrm{m/s}$ [constant], speed limit $10\ \mathrm{m/s}$

$a_p = 3.0\ \mathrm{m/s^2}$ [constant], find $V_p(t=10s)$:

$V_p = a_p t$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15 \text{ m/s}$ [constant], speed limit 10 m/s

$a_p = 3.0 \text{ m/s}^2$ [constant], find $V_p(t=10s)$:

$V_p = a_p t \Rightarrow V_p(t=10s) = (3.0 \text{ m/s}^2)(10s)$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \mathrm{m/s^2}$ (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,\mathrm{m/s}$ [constant], speed limit $10\,\mathrm{m/s}$

$a_p = 3.0\,\mathrm{m/s^2}$ [constant], find $V_p(t=10s)$:

$V_p = a_p t \Rightarrow V_p(t=10s) = (3.0\,\mathrm{m/s^2})(10s) = 30\,\mathrm{\frac{m}{s}}$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \text{m/s}^2$ (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\ \text{m/s}$ [constant], speed limit $10\ \text{m/s}$

$a_p = 3.0\ \text{m/s}^2$ [constant], find $V_p(t = 10\text{s})$:

$V_p = a_p t \Rightarrow V_p(t = 10\text{s}) = (3.0\ \text{m/s}^2)(10\text{s}) = 30\ \text{m/s}$

$$\boxed{V_p(10\text{s}) = 30\ \text{m/s}}$$

ASU

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,\text{m/s}$ [constant], speed limit 10 m/s

$a_p = 3.0\,\text{m/s}^2$ [constant],

ASU

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ m/s^2$ (Fig. 2.21a). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\ m/s$ [constant], speed limit $10\ m/s$

$a_p = 3.0\ m/s^2$ [constant], Find $x_p(t=10s)$

or $x_m(t=10s)$:

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration $3.0\ \mathrm{m/s^2}$ (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\ \mathrm{m/s}$ [constant], speed limit $10\ \mathrm{m/s}$

$a_p = 3.0\ \mathrm{m/s^2}$ [constant], Find $x_p(t=10s)$

or $x_m(t=10s)$:

$$x_m = V_m t$$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,\mathrm{m/s}$ [constant], speed limit $10\,\mathrm{m/s}$

$a_p = 3.0\,\mathrm{m/s^2}$ [constant], Find $x_p(t=10s)$

or $x_m(t=10s)$:

$$x_m = V_m t \Rightarrow x_m(10s) = \left(15\,\frac{m}{s}\right)(10s)$$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{mo} = x_{po} = 0$

$V_m = 15\,m/s$ [constant], speed limit $10\,m/s$

$a_p = 3.0\,m/s^2$ [constant], Find $X_p(t=10s)$

or $X_m(t=10s)$:

$$X_m = V_m t \Rightarrow X_m(10s) = \left(15\,\frac{m}{s}\right)(10s) = 150m$$

A motorist traveling at a constant 15 m/s (54 km/h, or about 34 mi/h) passes a school crossing where the speed limit is 10 m/s (36 km/h, or about 22 mi/h). Just as the motorist passes the school-crossing sign, a police officer on a motorcycle stopped there starts in pursuit with constant acceleration 3.0 m/s^2 (**Fig. 2.21a**). (a) How much time elapses before the officer passes the motorist? At that time, (b) what is the officer's speed and (c) how far has each vehicle traveled?

Let $x_{m0} = x_{p0} = 0$

$V_m = 15\,m/s$ [constant], speed limit 10 m/s

$a_p = 3.0\,m/s^2$ [constant], Find $x_p(t = 10s)$

or $x_m(t = 10s)$:

$$x_m = V_m t \Rightarrow x_m(10s) = \left(15\,\frac{m}{s}\right)(10s) = 150m$$

$$\Rightarrow \boxed{x_m(10s) = 150m}$$

ASU