1

Einvíð hreyfilýsing, hliðrun (ekki skoðað hvað veldur hreyfingunni)

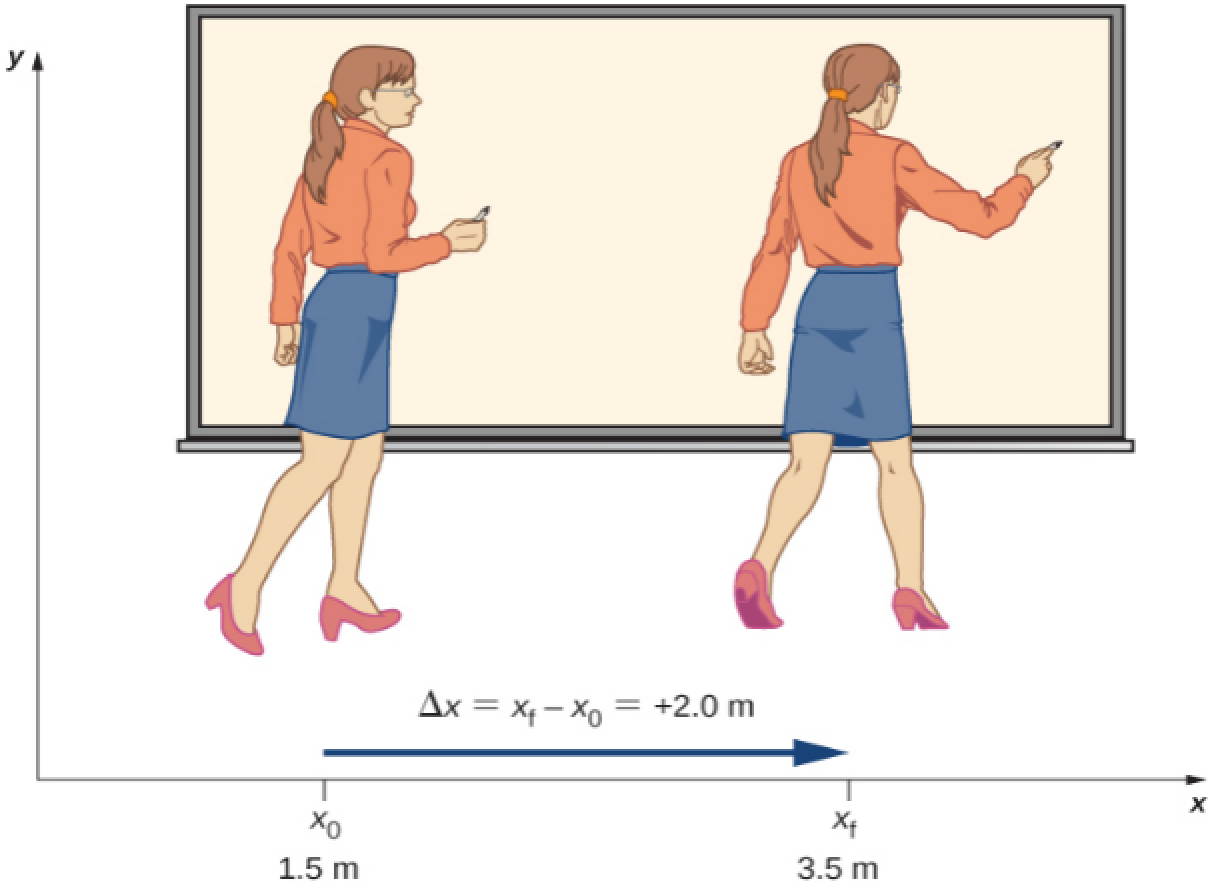

Figure 3.3 A professor paces left and right while lecturing. Her position relative to Earth is given by *x*. The +2.0-m displacement of the professor relative to Earth is represented by an arrow pointing to the right.

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Displacement

Displacement Δx is the change in position of an object:

$$\Delta x = x_f - x_0, \qquad (3.1)$$

where Δx is displacement, x_f is the final position, and x_0 is the initial position.

Meðalhraði

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Average Velocity

If x_1 and x_2 are the positions of an object at times t_1 and t_2, respectively, then

$$\text{Average velocity} = \bar{v} = \frac{\text{Displacement between two points}}{\text{Elapsed time between two points}} \qquad 3.3$$

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}.$$

Takið eftir að meðalhraðinn getur orðið neikvæður, stefna vigurs í 1-D fer eftir formerki eina hnits hans ...

Skoðum hreyfingu

A sketch of Jill's movements is shown in Figure 3.4.

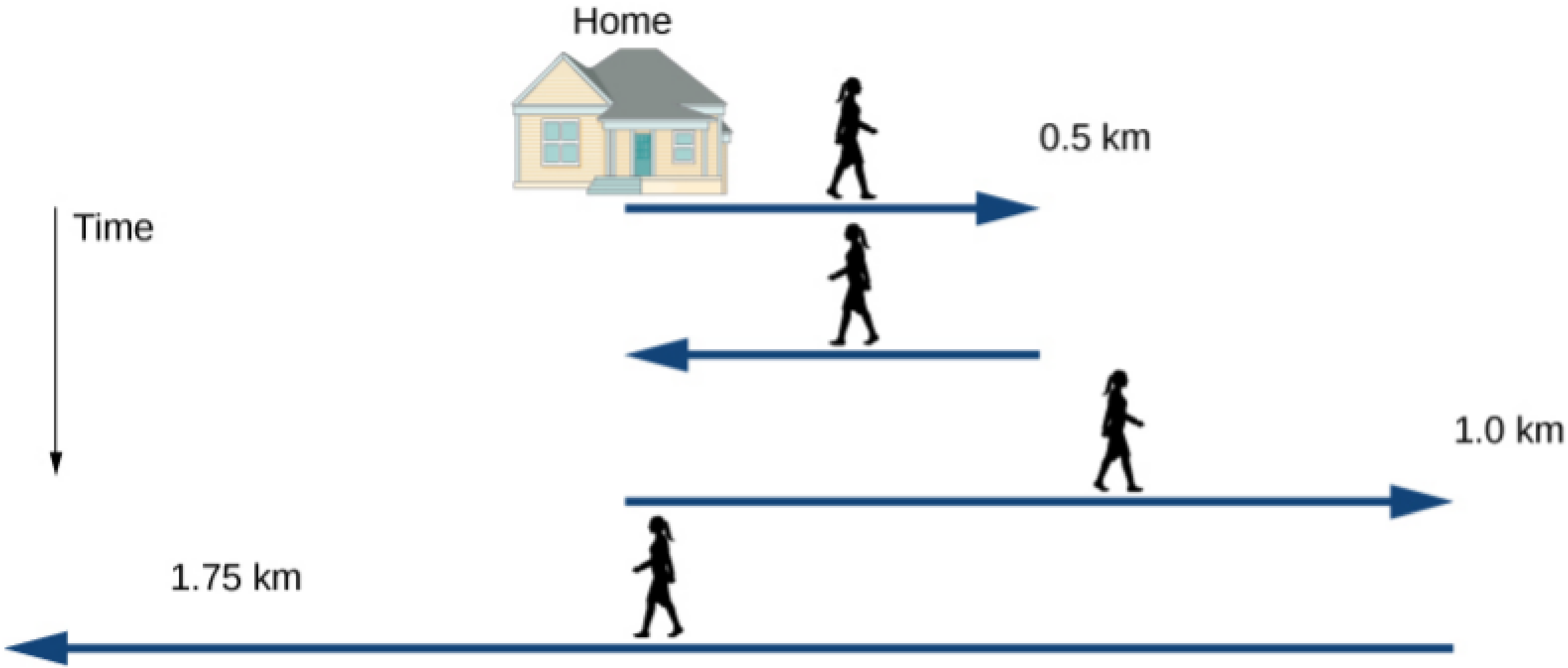

Figure 3.4 Timeline of Jill's movements.

Time t_i (min)	Position x_i (km)	Displacement Δx_i (km)
$t_0 = 0$	$x_0 = 0$	$\Delta x_0 = 0$
$t_1 = 9$	$x_1 = 0.5$	$\Delta x_1 = x_1 - x_0 = 0.5$
$t_2 = 18$	$x_2 = 0$	$\Delta x_2 = x_2 - x_1 = -0.5$
$t_3 = 33$	$x_3 = 1.0$	$\Delta x_3 = x_3 - x_2 = 1.0$
$t_4 = 58$	$x_4 = -0.75$	$\Delta x_4 = x_4 - x_3 = -1.75$

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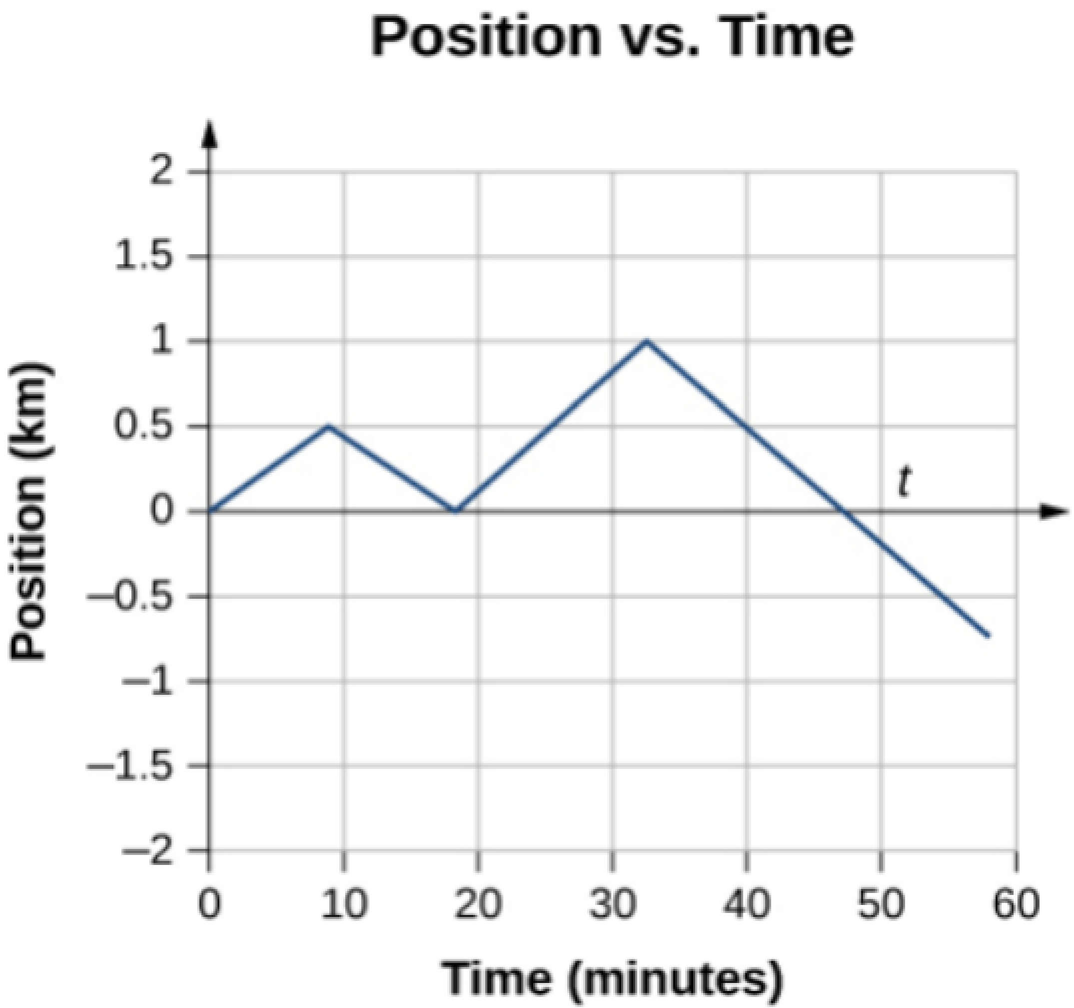
Myndræn framsetning, graf



Ekki gott dæmi til að skoða hröðun...

Getum lesið meðalhraðann beint af grafinu

Viljum frekar notast við staðsetningu, og hraða og hröðun í hverjum tímapunkti

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Hraði á vissum tímapunkti

$$v(t) = \lim_{\Delta t \to 0} \frac{x(t + \Delta t) - x(t)}{\Delta t} = \frac{dx(t)}{dt}.$$

Instantaneous Velocity

The instantaneous velocity of an object is the limit of the average velocity as the elapsed time approaches zero, or the derivative of x with respect to t:

$$v(t) = \frac{d}{dt}x(t). \qquad 3.4$$

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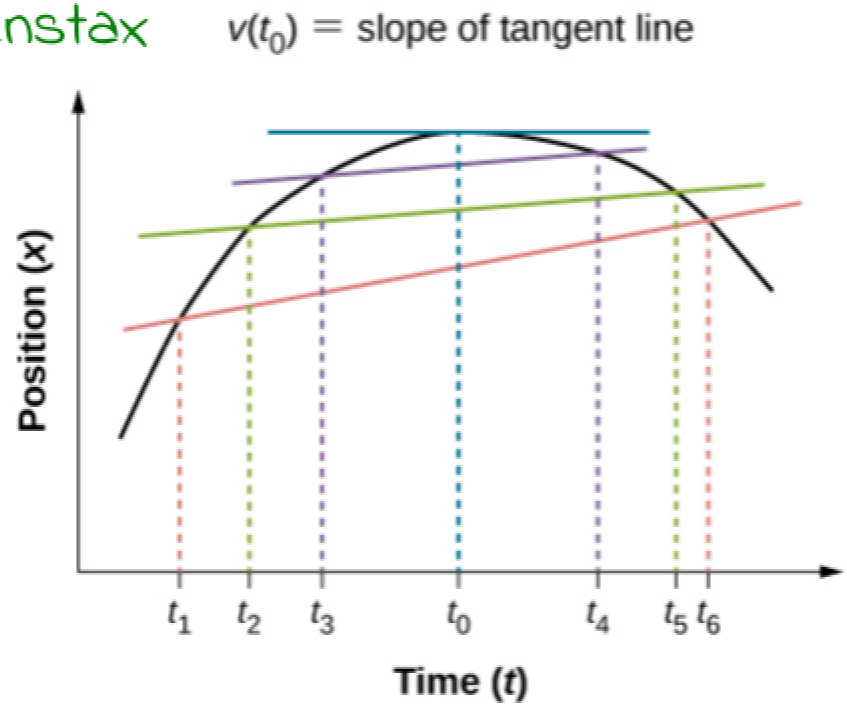

Hér sést hvernig rétt gildi fæst þegar tímabilið verður æ styttra

Dæmi (Ex. 3.4 í bók)

eining metrar

$$x(t) = \left(3t - 3t^2\right) m$$

$$v(t) = \frac{dx(t)}{dt} = \left(3 - 6t\right) m/s$$

einvíðir vigrar, staða og hraði

ferð (speed)

$$|v(t)| = |3 - 6t| \; m/s$$

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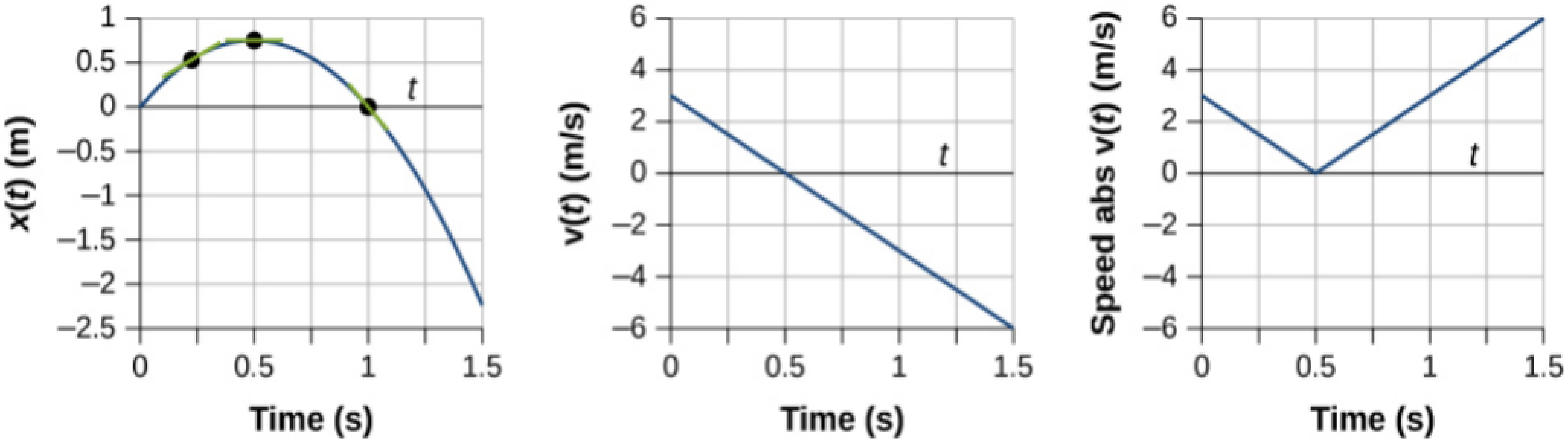


(a) Position (b) Velocity (c) Speed

Meðalhröðun -- hröðun, (vigurstærðir)

Average Acceleration

Average acceleration is the rate at which velocity changes:

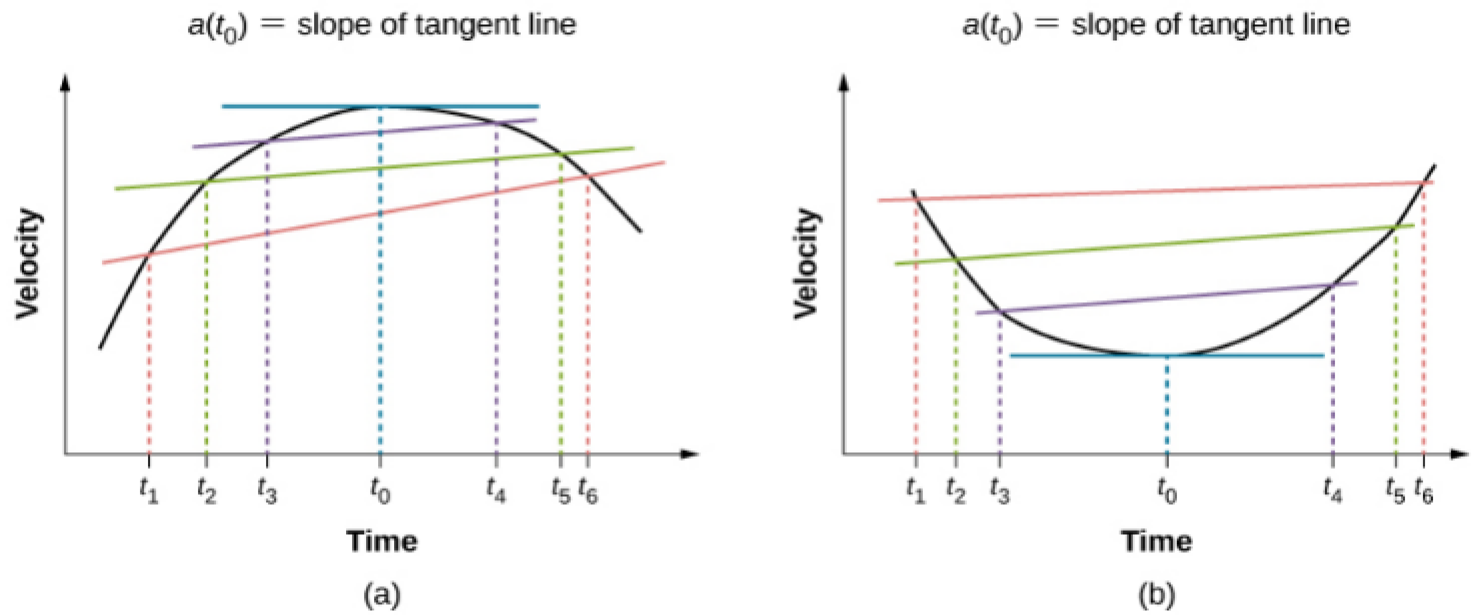
$$\overline{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_0}{t_f - t_0}, \qquad 3.8$$

where $\overline{a}$ is **average acceleration**, v is velocity, and t is time. (The bar over the a means *average* acceleration.)

heppilegra að nota <a> fyrir meðaltal af stærðinni a í handskrift

Hröðun á tímapunkti

$$a(t) = \frac{d}{dt}v(t).$$



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Dæmi (Ex. 3.6)

$$\bar{v}(t) = (20t - 5t^2)\ \mathrm{m/s}$$

$$\rightarrow \bar{a}(t) = (20 - 10t)\ \mathrm{m/s^2}$$

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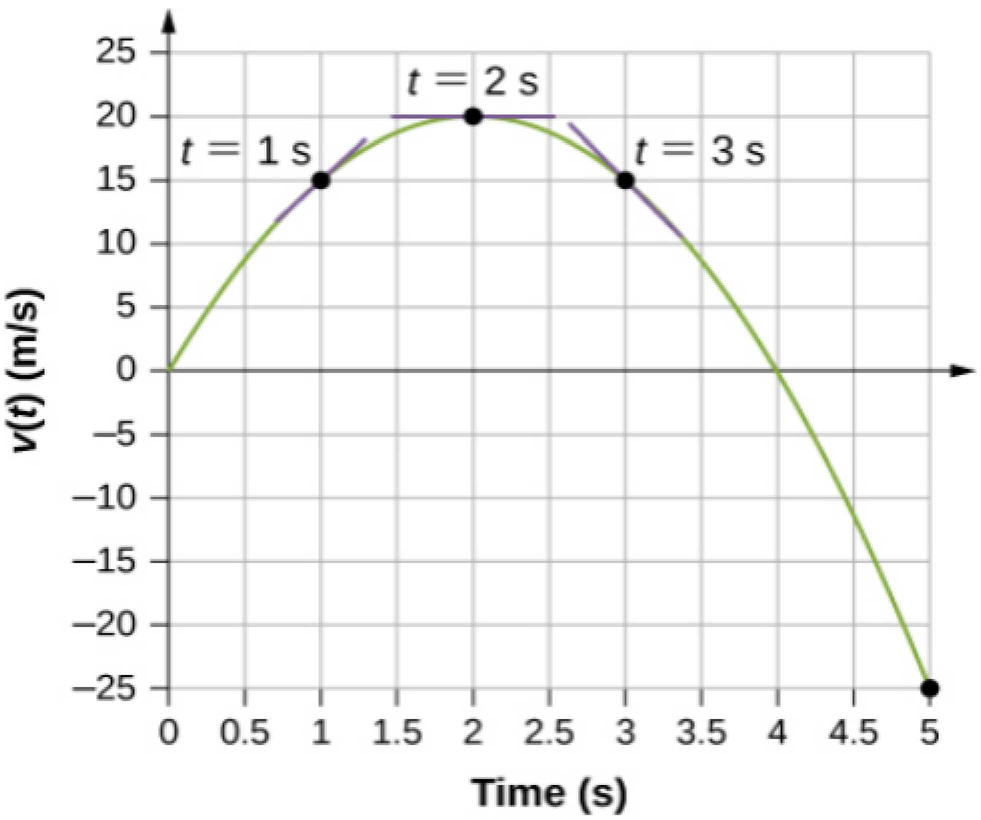
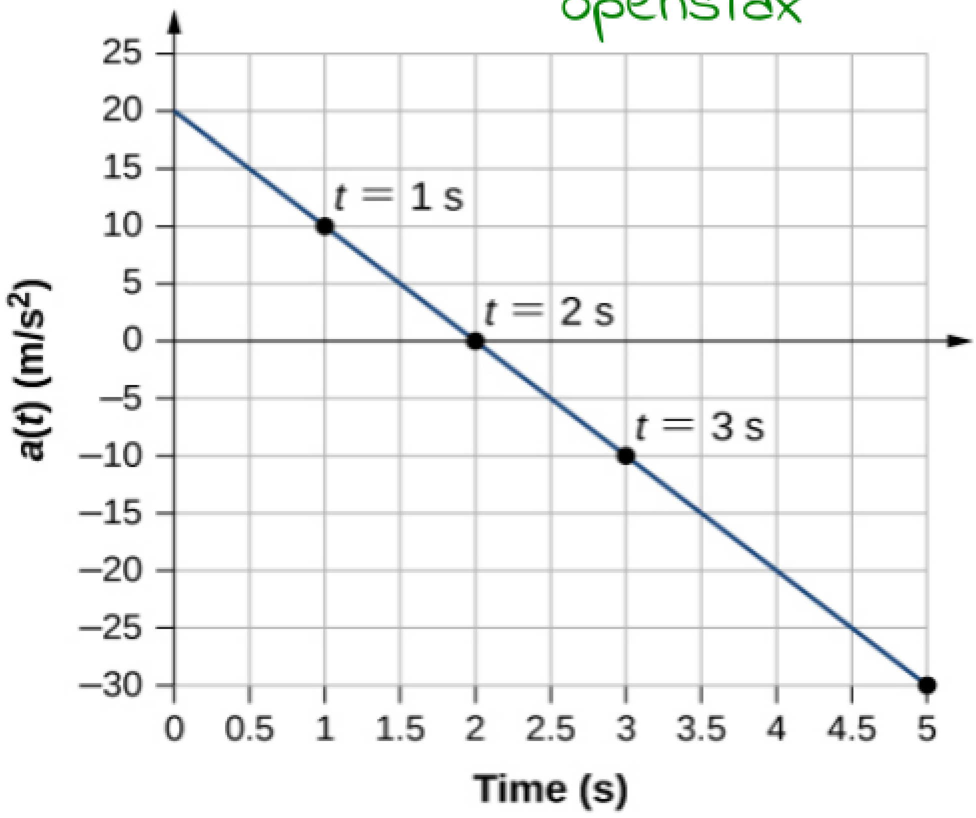


(a) Velocity



(b) Acceleration

Einvíð hreyfing með fastri hröðun a

Almennt gildir $$\frac{dv(t)}{dt} = a(t)$$

Skoðum sértilfellið $$\frac{dv(t)}{dt} = a \,, \quad a \text{ er fasti}$$

$$\rightarrow \quad \frac{dv(t)}{dt}\,dt = a\,dt \quad \rightarrow \quad dv(t) = a\,dt$$

$$\rightarrow \quad \int_{v_0}^{v(t)} dv'(t) = a\int_{t_0}^{t} dt' \quad \rightarrow \quad v(t) - v_0 = a(t - t_0)$$

1

$$\rightarrow \quad \boxed{v(t) = v_0 + a(t - t_0)}$$

Almennt gildir $\frac{dx(t)}{dt} = v(t) \rightarrow \frac{dx(t)}{dt} dt = v(t) dt$

Heildum $\int_{x_0}^{x(t)} dx'(t) = \int_{t_0}^{t} v(t') dt' = \int_{t_0}^{t} dt' \left[v_0 + a(t' - t_0) \right]$

$$\rightarrow x(t) - x_0 = v_0 (t - t_0) + \frac{1}{2} a \left(t^2 - t_0^2 \right) - a t_0 (t - t_0)$$

$$= v_0 (t - t_0) + \frac{1}{2} a (t - t_0)^2$$

2

$$\rightarrow \boxed{x(t) = x_0 + v_0 (t - t_0) + \frac{1}{2} a (t - t_0)^2}$$

Þurfum við að taka saman þessar tvær jöfnur til að losna við t og finna samband staðsetningar og hraða?

1 $\rightarrow$ $$(t - t_0) = \frac{v(t) - v_0}{a}$$

2 $\rightarrow$ $$x(t) - x_0 = v_0 (t - t_0) + \frac{a}{2}(t - t_0)^2$$

$\rightarrow$ $$x(t) - x_0 = v_0 \left(\frac{v(t) - v_0}{a}\right) + \frac{a}{2}\frac{(v(t) - v_0)^2}{a^2}$$

$$= \frac{v^2(t) - v_0^2}{2a}$$

3 $\rightarrow$ $$\boxed{v^2(t) = v_0^2 + 2a\left(x(t) - x_0\right)}$$

Frjálst fall, (einvídd)

Hreyfijöfnurnar fyrir frjálsu falli fást því með að setja "a --> -g" þar sem þyngdarhröðunin er valin t.d. sem $g = 9.81\ m/s^2$

$$a = -g$$

$$v(t) = v_0 - g(t - t_0)$$

$$y(t) = y_0 + v_0(t - t_0) - \frac{g}{2}(t - t_0)^2$$

$$v^2(t) = v_0^2 - 2g(y - y_0)$$

Þær má einfalda með vali á upphafsgildum, en mikilvægt er að taka eftir og halda réttu bókhaldi um formerkin