Physics 20

Unit A: Motion in one and two dimensions

Velocity and acceleration graphs

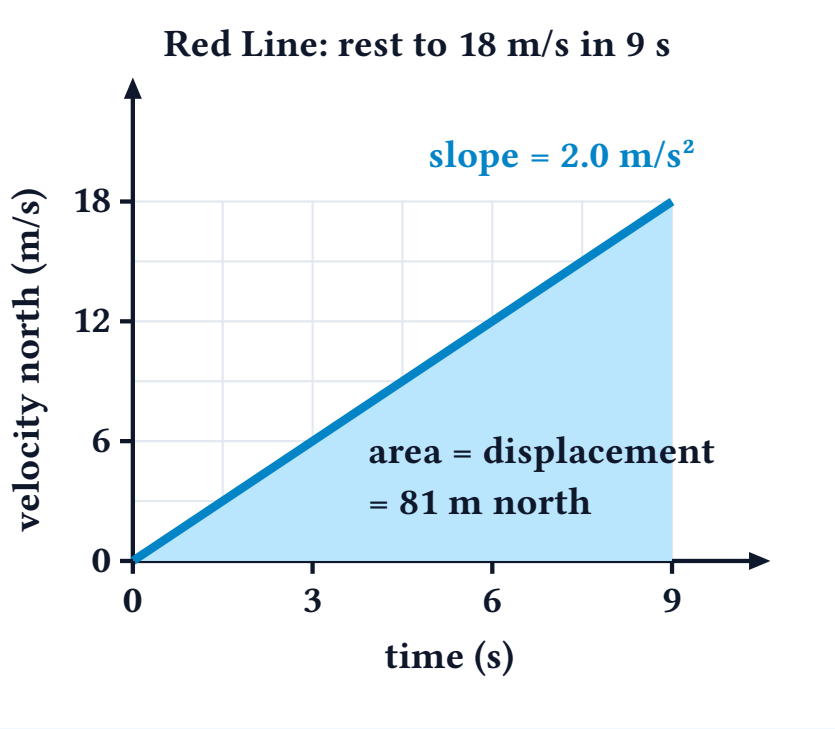
An LRT departure

- A Calgary CTrain on the Red Line leaves Somerset-Bridlewood from rest and reaches 18.0 m/s north in 9.00 s.
- Average velocity uses displacement over elapsed time, and acceleration uses the velocity change over elapsed time.



Rates and graphs

- Delta means final minus initial.
- Velocity v equals delta d divided by delta t. Here d is position and t is time.
- Acceleration a equals delta v divided by delta t.
- Uniform motion keeps the same velocity. Uniformly accelerated motion keeps the same acceleration.



Key terms

velocity

Velocity is displacement divided by elapsed time, and the statement includes the direction of the motion. (v = delta d / delta t)

acceleration

Acceleration is the change in velocity divided by elapsed time, and the statement includes direction. (a = delta v / delta t)

uniform motion

Uniform motion is motion at constant velocity, so equal displacements occur in equal time intervals.

uniformly accelerated motion

Uniformly accelerated motion is motion at constant acceleration, so velocity changes by equal amounts in equal times.

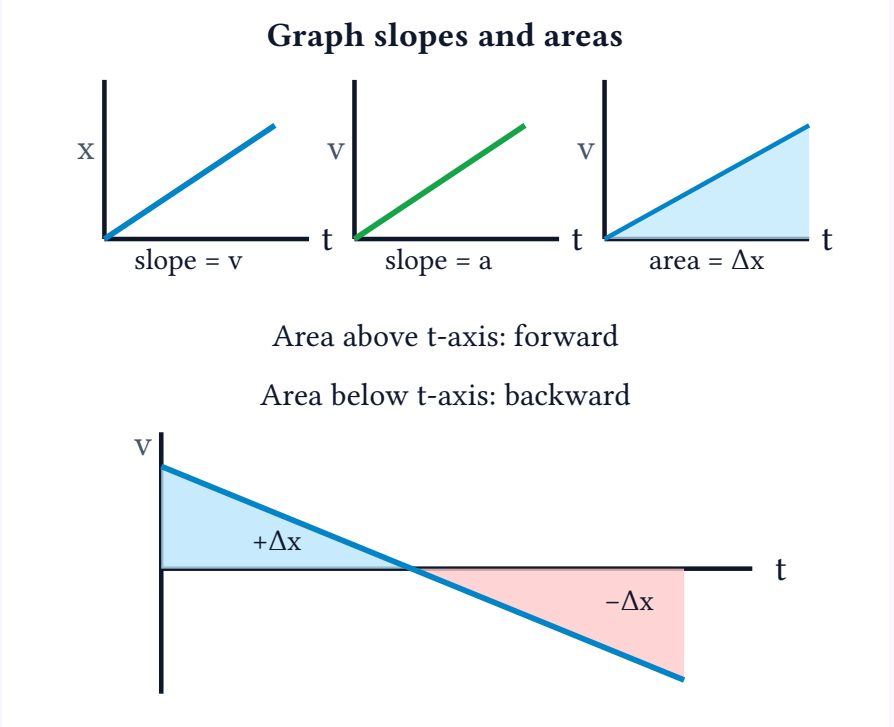
Key terms

delta notation

Delta notation writes a change as the final value of a quantity minus its initial value. $\Delta v = v_{final} - v_{initial} = 18.0\frac{m}{s} - 0\frac{m}{s} = 18.0\frac{m}{s}$. (Δ)

Slope and area of graphs

- The slope of a position time graph is the velocity.
- The slope of a velocity time graph is the acceleration.
- The area under the velocity time line equals the displacement. Area above the time axis is forward. Area below it is backward.

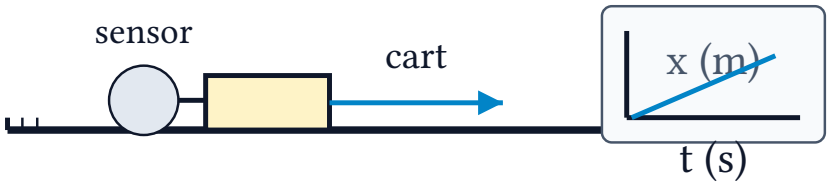


Three equations for constant acceleration

- From rest, $v = 0 + (2.0\ m/s^2)(9.00\ s) = 18\ m/s$ north.
- Displacement is $(1/2)(2.0\ m/s^2)(9.00\ s)^2 = 81\ m$ north.
- Check: $v^2 = 0 + 2(2.0\ m/s^2)(81\ m) = (18\ m/s)^2$.

Cart lab plan

- The lab question is: how do displacement, velocity, acceleration, and time connect for one cart?
- A motion sensor records position together with the clock time.
- Write metres and seconds, keep the digits the timer supports, and write each change as final minus initial.



Cart and motion sensor

Record x and t; use Δ = final − initial

A sensor record of a slowing cart

- The motion sensor shows a cart at 6.00 m/s east, then at 2.00 m/s east after 4.00 s.
- Find the acceleration and the displacement during that interval.
- State the acceleration direction relative to the chosen positive direction.

Formula and graph area

- A lab cart starts from rest and accelerates at 0.800 m/s^2 west for 5.00 s.
- Find the final velocity and the displacement.
- The triangle under the velocity time line has an area equal to the displacement.

Image credits

Bernard Spragg, Calgary Lightrail. C Train, CC0 1.0