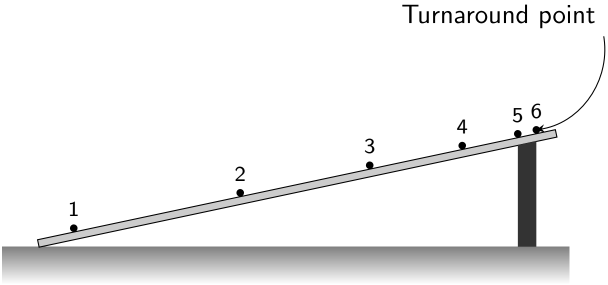
PHYS2350: Acceleration in 1D

Dr. Wolf

Fall 2024

Motion with decreasing speed

Making a velocity diagram:



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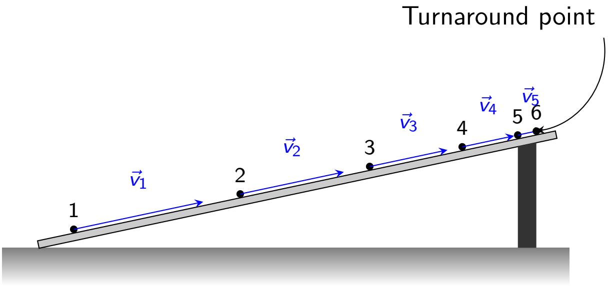

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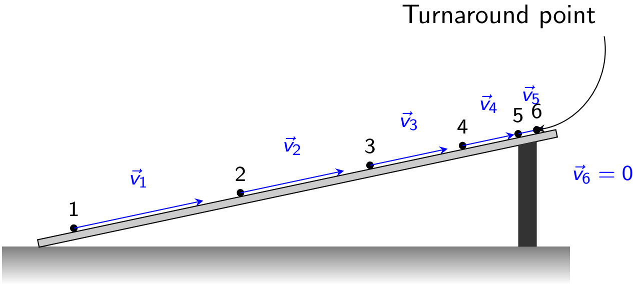

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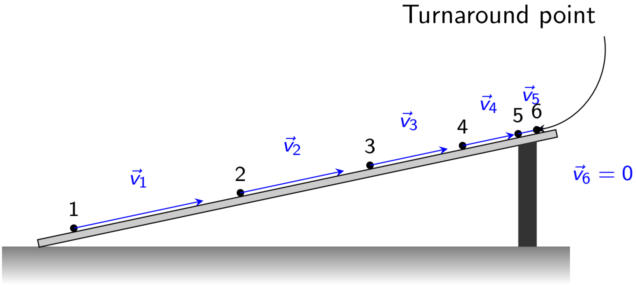
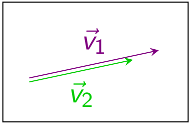


Compare $\vec{v}_1$, $\vec{v}_2$, and $\Delta\vec{v}_{12}$:



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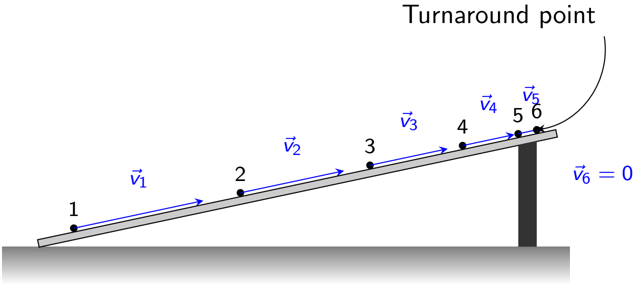

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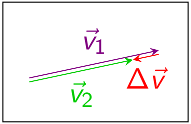

Does it matter which instants we pick?

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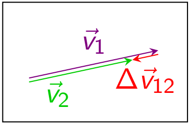

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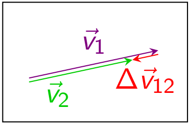
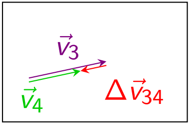


Compare $\vec{v}_3, \vec{v}_4$, and $\Delta\vec{v}_{34}$:



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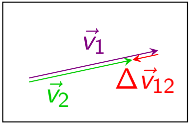

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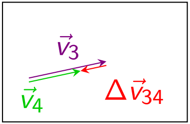


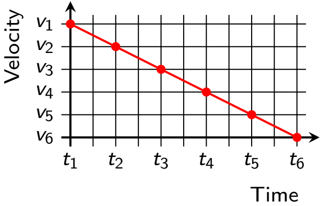
Answer

$\Delta\vec{v}$ is always opposite the instantaneous velocity $\vec{v}$ when speed is *decreasing*.

Change in velocity vector and acceleration

We can assume that the scale on this graph is accurate. For example, one box length represents:

- 1 second on the x-axis
- 1 m/s on the y-axis



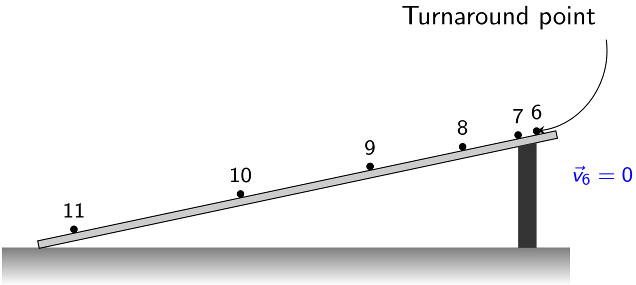
Note: The positive direction has been chosen to be *up* the track.

Motion with decreasing speed

Summary:

- $\Delta\vec{v}$ is always opposite in direction from $\vec{v}$
- $\vec{a}$ is always opposite in direction from $\vec{v}$
- $\Delta\vec{v}$ and $\vec{a}$ are always pointing *down the ramp*.

Motion with increasing speed



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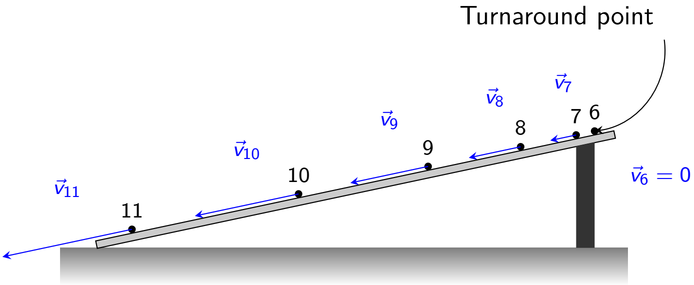

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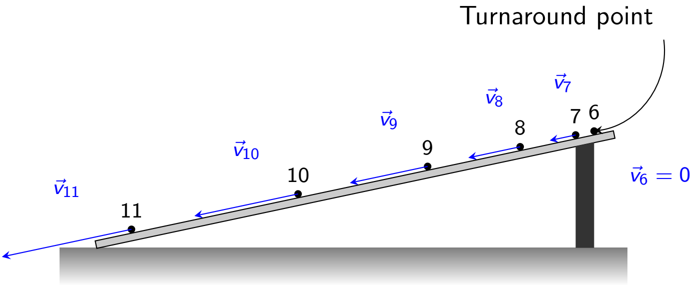

Summary:

- $\Delta\vec{v}$ is always in the same direction as $\vec{v}$
- $\vec{a}$ is always in the same direction as $\vec{v}$
- $\Delta\vec{v}$ and $\vec{a}$ are always pointing *down the ramp*.

Motion that includes a change in direction

Consider the velocity at instants 5 and 7:

Find the *change in velocity* vector, Δv for this scenario

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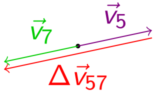

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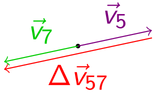

Find the *change in velocity* vector, Δv for this scenario

Direction of $\Delta\vec{v}$ and $\vec{a}$

- $\Delta\vec{v}$ and $\vec{a}$ are always pointing *in the same direction*.
- $\Delta\vec{v}$ and $\vec{a}$ are always pointing *down the ramp*.

Make a graph

For the motion of the ball on the ramp, make graphs of x vs. t, v vs. t, and a vs. t. Choose your origin to be at the bottom of the ramp, and the

Kinematic equations in 1D

Also called the "Constant acceleration equations".

$$x(t) = x_i + v_i t + \frac{1}{2}at^2 \tag{1}$$

$$v(t) = v_i + at \tag{2}$$

$$v_f^2 - v_i^2 = 2a(x_f - x_i) \tag{3}$$

Equation (3) is obtained by solving (2) for t and plugging into (1), then simplifying. It assumes $x(t) = x_f$ and $v(t) = v_f$.