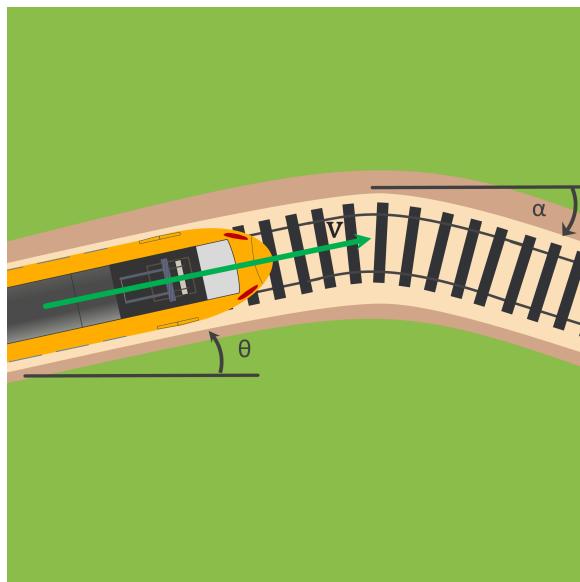


Train in a Curve



A train is taking a sudden curve as shown in the figure. Decompose the velocity into the new normal tangential coordinates for the train when it just took the turn. $\theta = 15^\circ$ and $\alpha = 10^\circ$.

Given quantities:

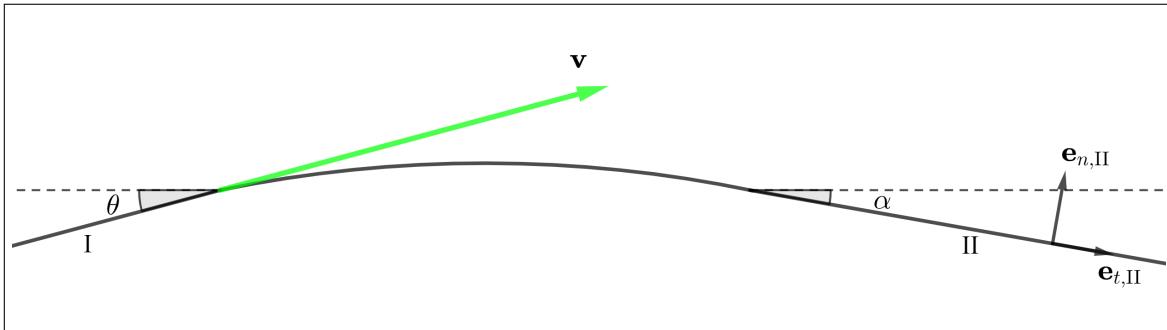
Angle: $\theta = 15^\circ$

Angle: $\alpha = 10^\circ$

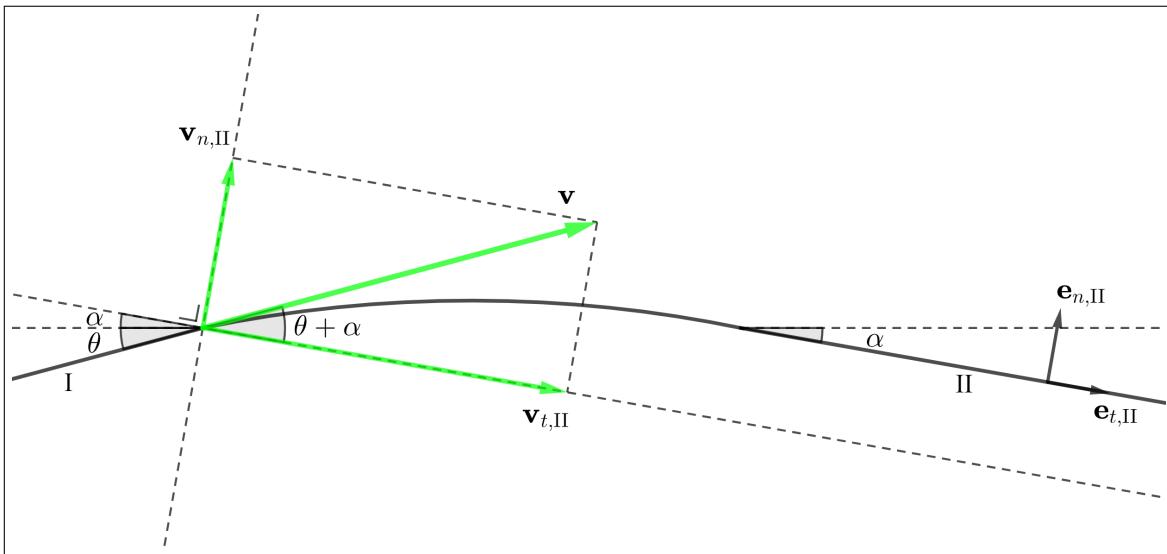
Train speed: $v = |\mathbf{v}|$

Solution:

Firstly, the train trajectory is split into the corner and the prior and posterior straight sections. We decide to name the prior straight as section I and the posterior straight as section II. Since the train is currently at section I, its velocity is tangent to this straight. Figure shows a schematic diagram of the situation. The normal and tangent coordinate system at section II is also included ($\mathbf{e}_{n,II}$ and $\mathbf{e}_{t,II}$).



We then decompose \mathbf{v} into the normal and tangential coordinate system at section II. This is done by drawing a straight line tangent to $\mathbf{e}_{n,II}$ and through the point of the velocity and a straight line tangent to $\mathbf{e}_{n,II}$ through the point of the velocity. These straight lines are perpendicular to each other. Decomposition is now done via simple projection of \mathbf{v} onto both lines, respectively to obtain $\mathbf{v}_{n,II}$ and $\mathbf{v}_{t,II}$.



Notice $\mathbf{v}_{n,II}$ and $\mathbf{v}_{t,II}$ span a perfect rectangle. Because $\mathbf{v}_{n,II}$ and $\mathbf{v}_{t,II}$ are perpendicular, standard trigonometry rules for a right triangle can be applied, giving the final expressions for both velocity components:

$$v_{t,II} = |\mathbf{v}_{t,II}| = |\mathbf{v}| \cos(\theta + \alpha) = v \cos(15^\circ + 10^\circ) = v \cos(25^\circ) \quad (1)$$

$$v_{n,II} = |\mathbf{v}_{n,II}| = |\mathbf{v}| \sin(\theta + \alpha) = v \sin(15^\circ + 10^\circ) = v \sin(25^\circ) \quad (2)$$