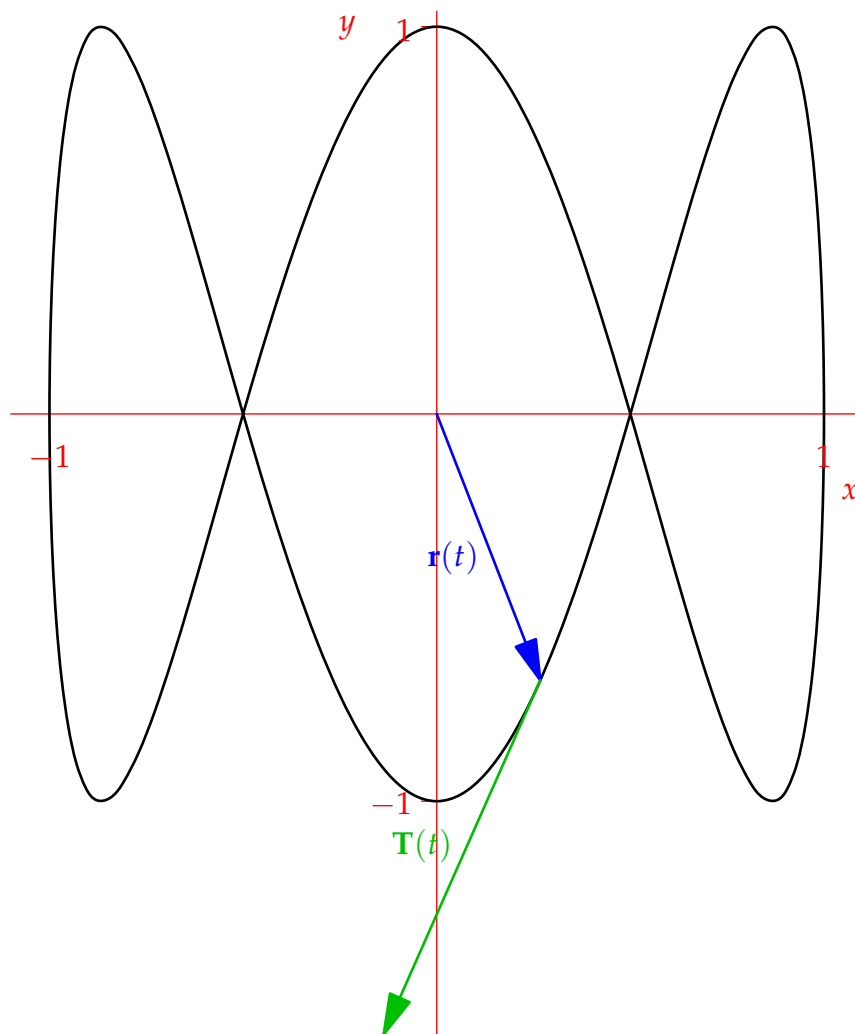


Unit Tangent Vector Animation

Unit Tangent Vector: $\mathbf{T}(t) = \frac{1}{|\mathbf{r}'(t)|} \mathbf{r}'(t)$ where $\mathbf{r}' = \frac{d\mathbf{r}}{dt}$

Example: $\mathbf{r}(t) = \begin{pmatrix} x(t) \\ y(t) \end{pmatrix} = \begin{pmatrix} \cos t \\ \sin 3t \end{pmatrix}, \quad 0 \leq t < 2\pi$



Osculating Circle Animation

Unit Normal Vector: $\mathbf{N}(t) = \frac{\mathbf{T}'(t)}{|\mathbf{T}'(t)|}$

Curvature: $\kappa(t) = \frac{|\mathbf{T}'(t)|}{|\mathbf{r}'(t)|} = \frac{|\mathbf{r}'(t) \times \mathbf{r}''(t)|}{|\mathbf{r}'(t)|^3}$

Radius of **osculating circle** $R = \frac{1}{\kappa}$

