February 6, Week 4

Today: Chapter 3, Two-Dimensional Motion

Homework Assignment #3 due Tonight
Mastering Physics: 6 problems.
Written Problem: 2.88.

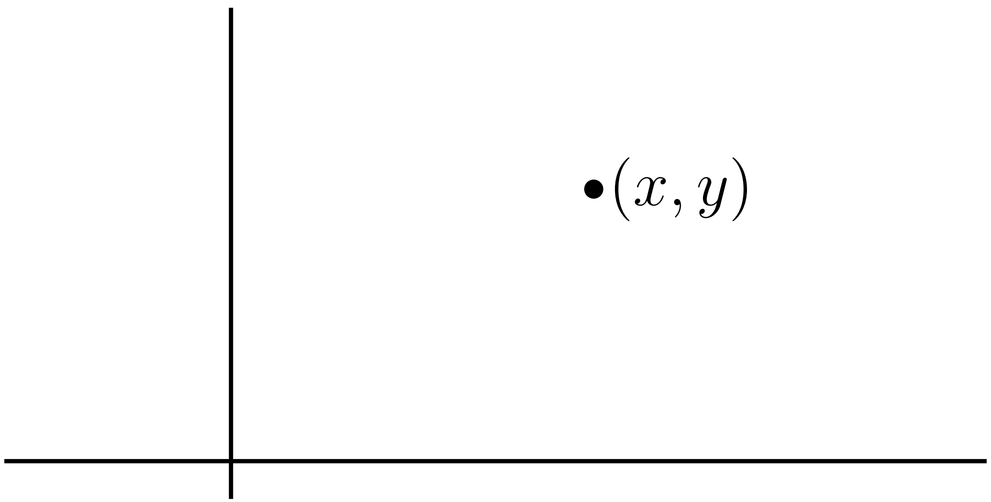
Homework #1 now in boxes.

No New homework assignment this week.

Exam #1 Friday, February 10.

Practice Exam available on website.
Review Session, Thursday, 7:30 PM.
Chapter 2 practice problems on Mastering Physics.

Review



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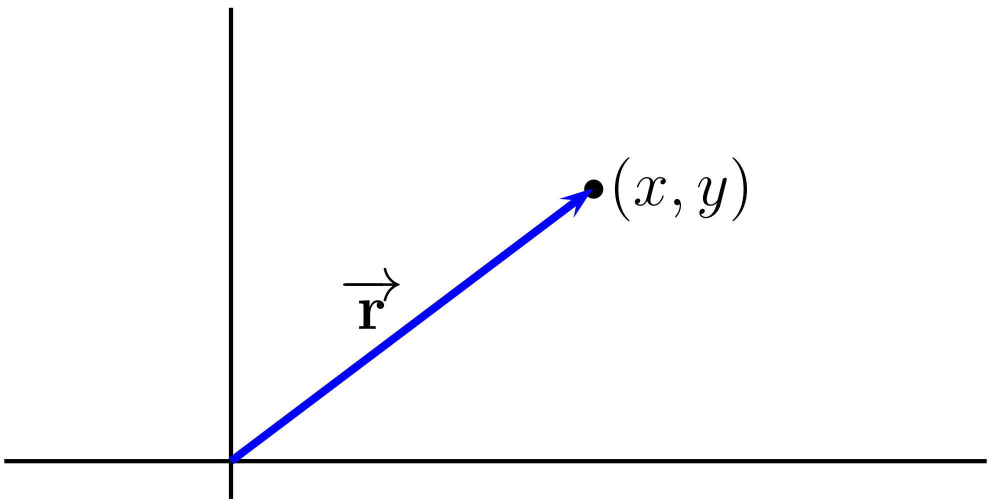

$\vec{\mathbf{r}} = x\hat{\boldsymbol{\imath}} + y\hat{\boldsymbol{\jmath}}$

$\Rightarrow$ the position vector goes from the origin to the object's location.

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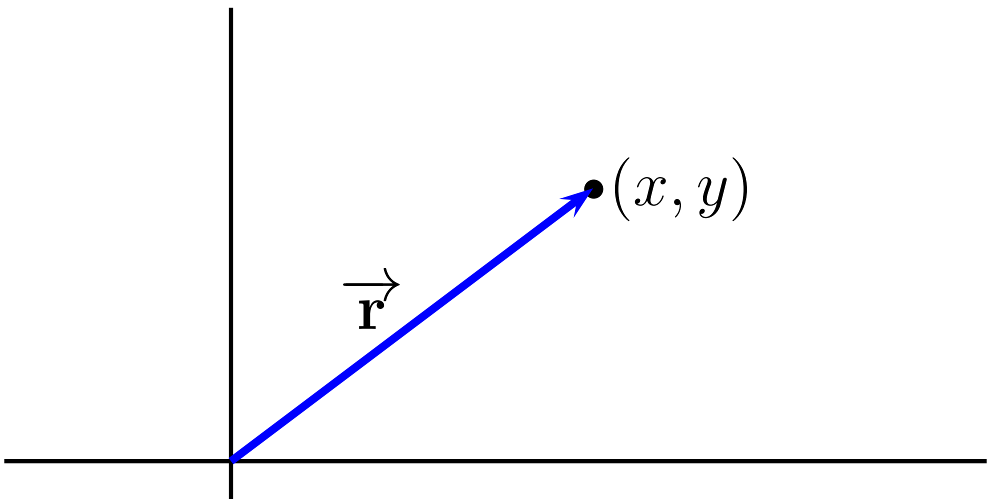

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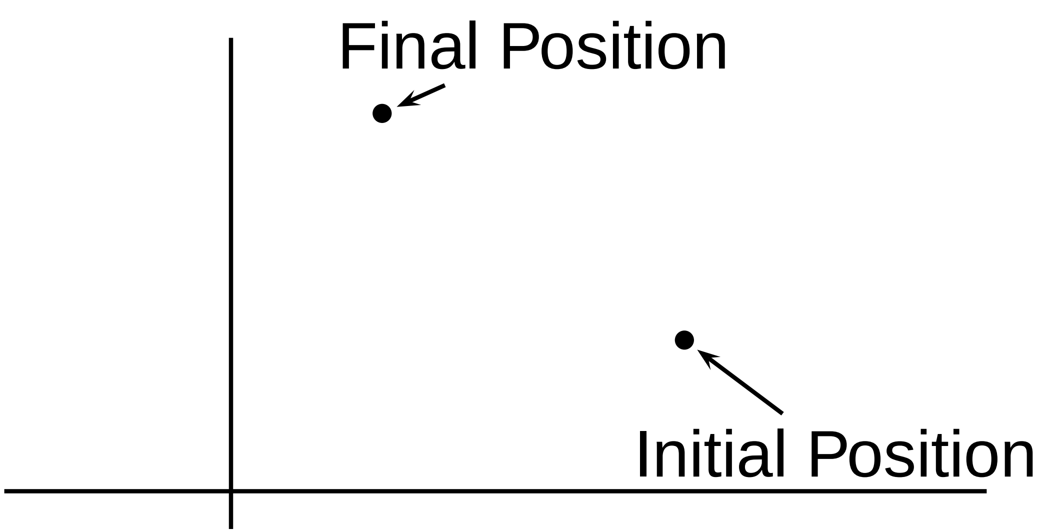

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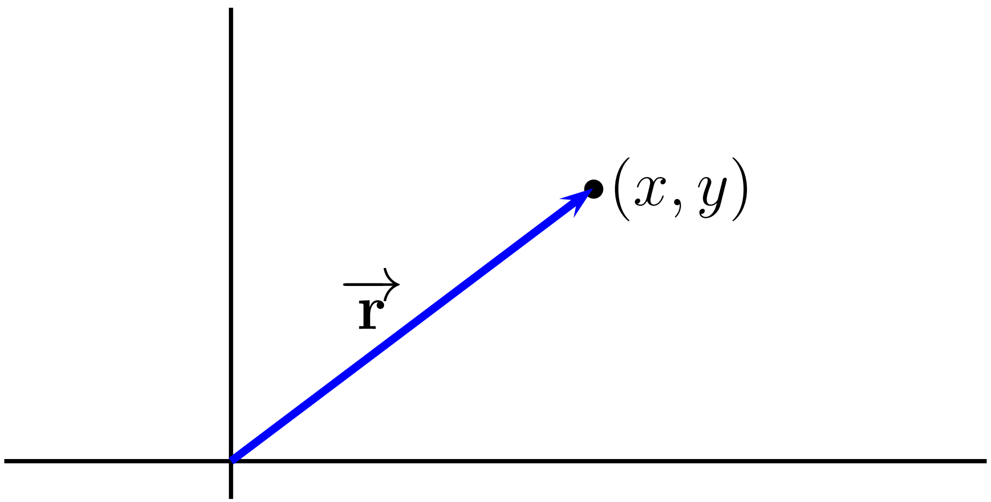

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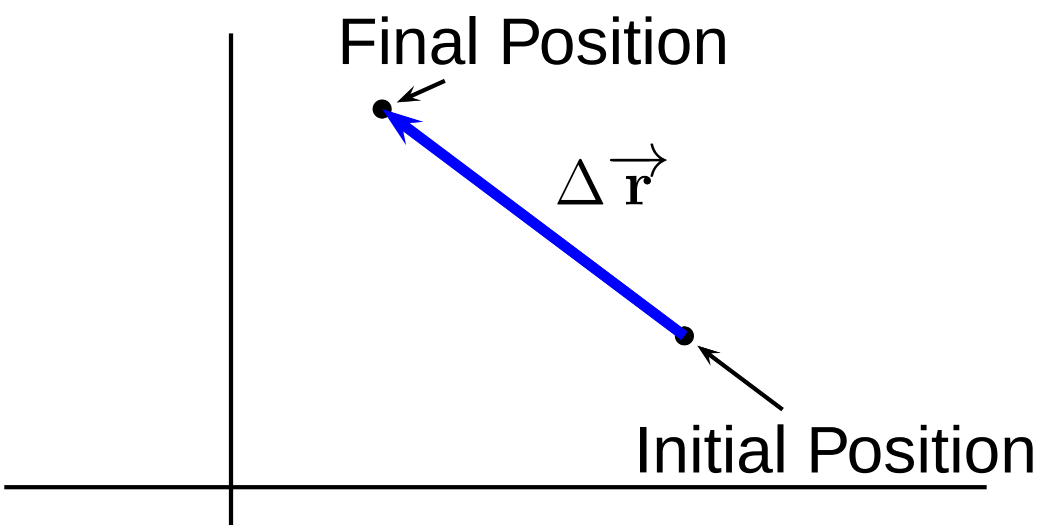

$$\Delta\overrightarrow{\mathbf{r}} = \overrightarrow{\mathbf{r}}_2 - \overrightarrow{\mathbf{r}}_1$$

Review II

Velocity = Speed and direction.

$$\overrightarrow{\mathbf{v}} = \lim_{\Delta t \to 0} \frac{\Delta \overrightarrow{\mathbf{r}}}{\Delta t} = \frac{d\,\overrightarrow{\mathbf{r}}}{dt}$$

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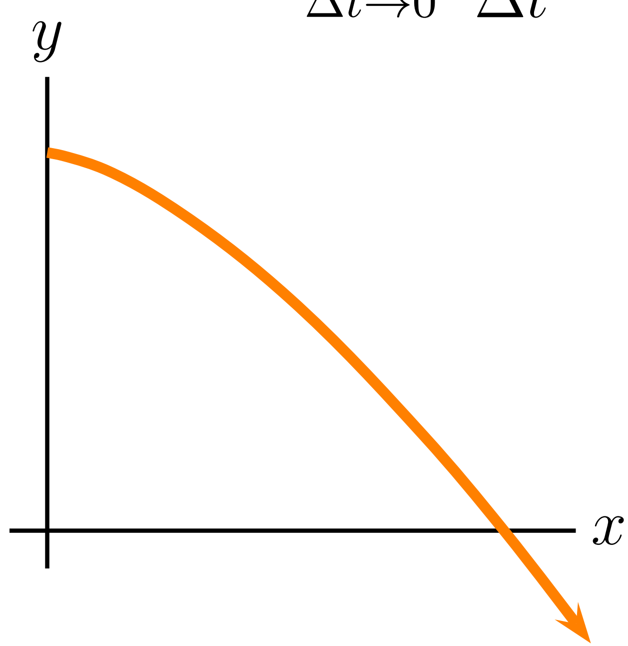

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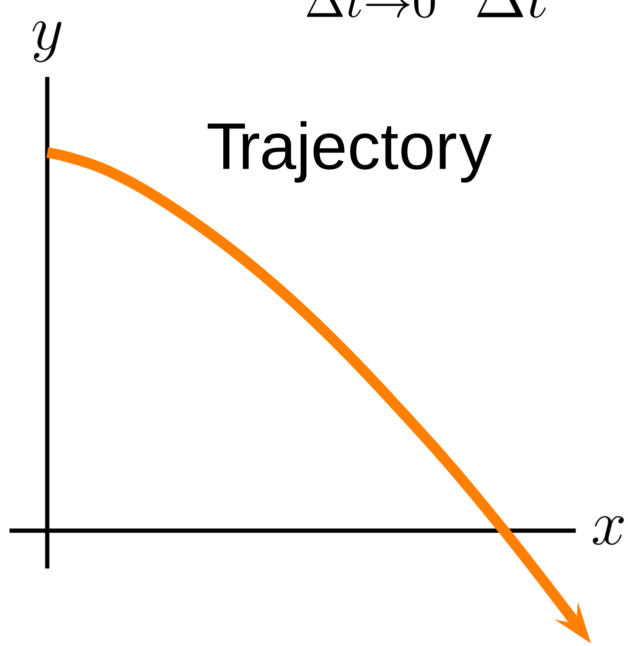

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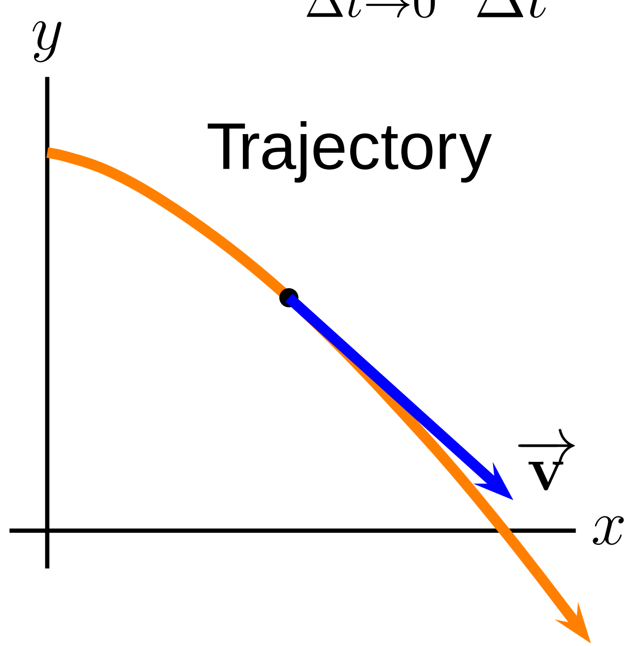

$\vec{\mathbf{v}}$ is tangent to trajectory

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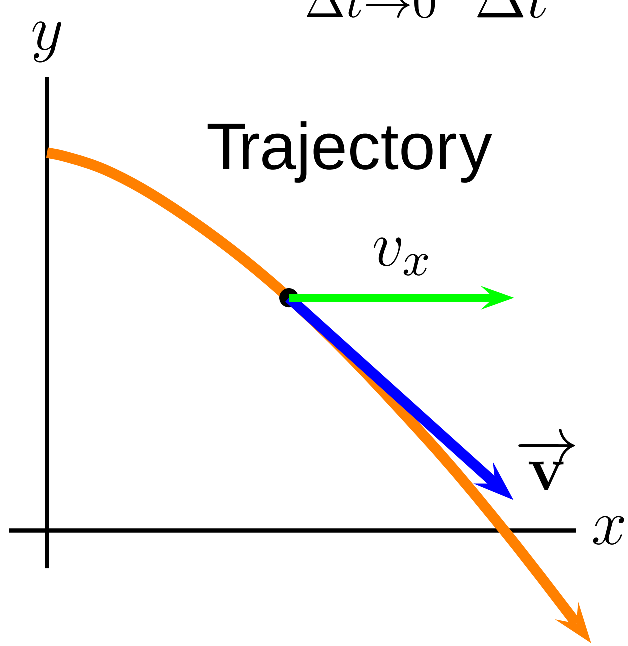

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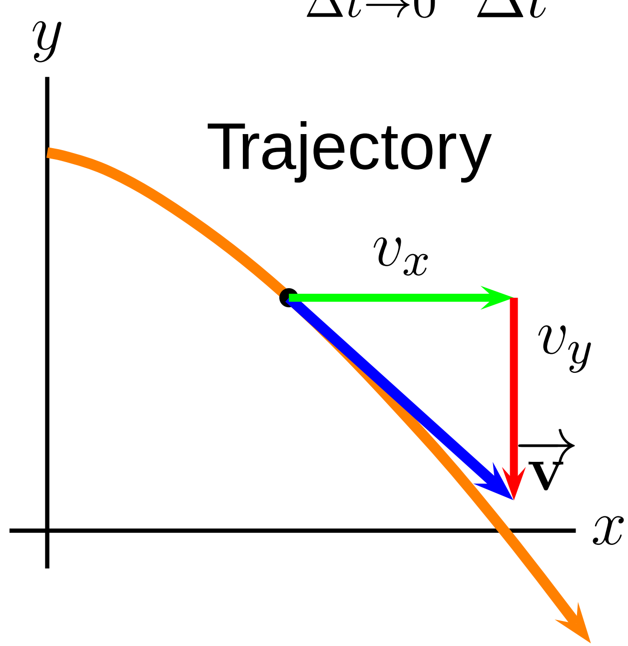

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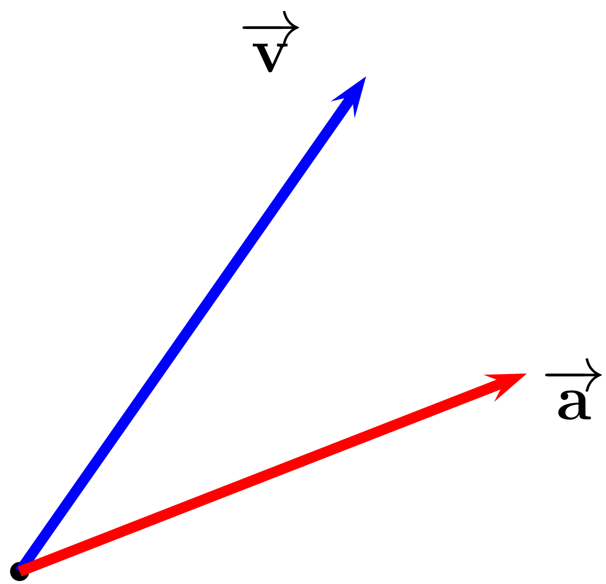
$$v_x = \frac{dx}{dt}$$

$$v_y = \frac{dy}{dt}$$

Review III

An acceleration in an arbitrary direction will cause a change in both speed and direction.



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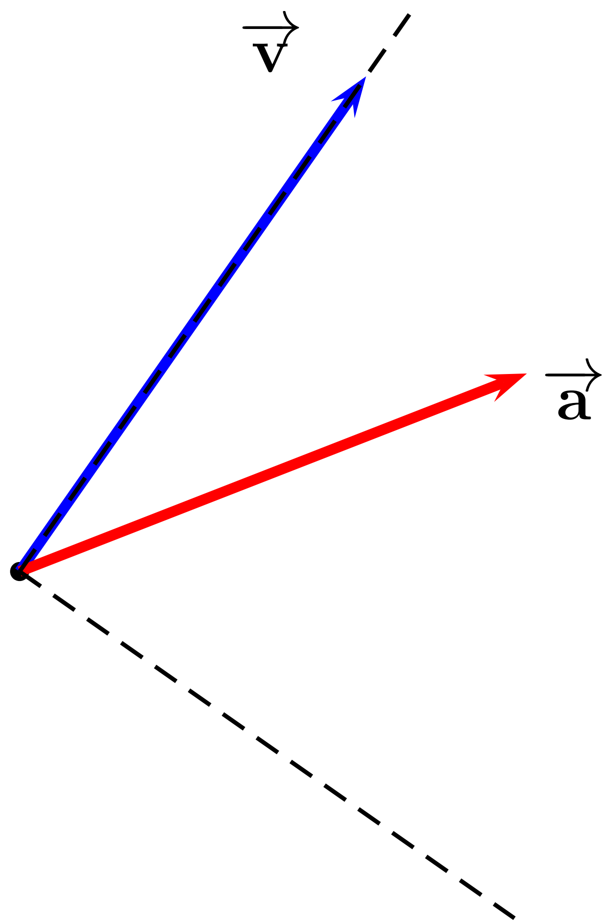

Use coordinates parallel and perpendicular to $\vec{\mathbf{v}}$

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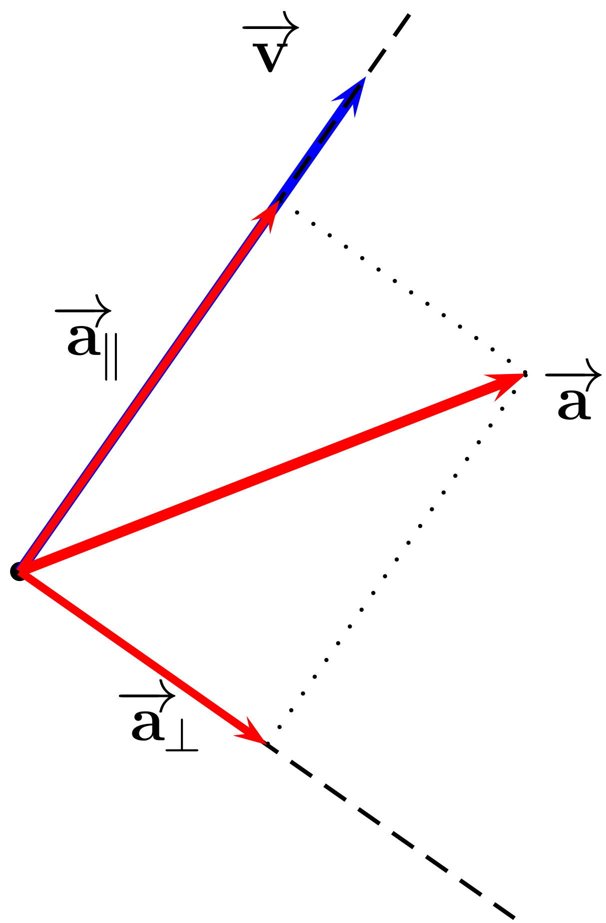

Split into components parallel and perpendicular to $\vec{\mathbf{v}}$

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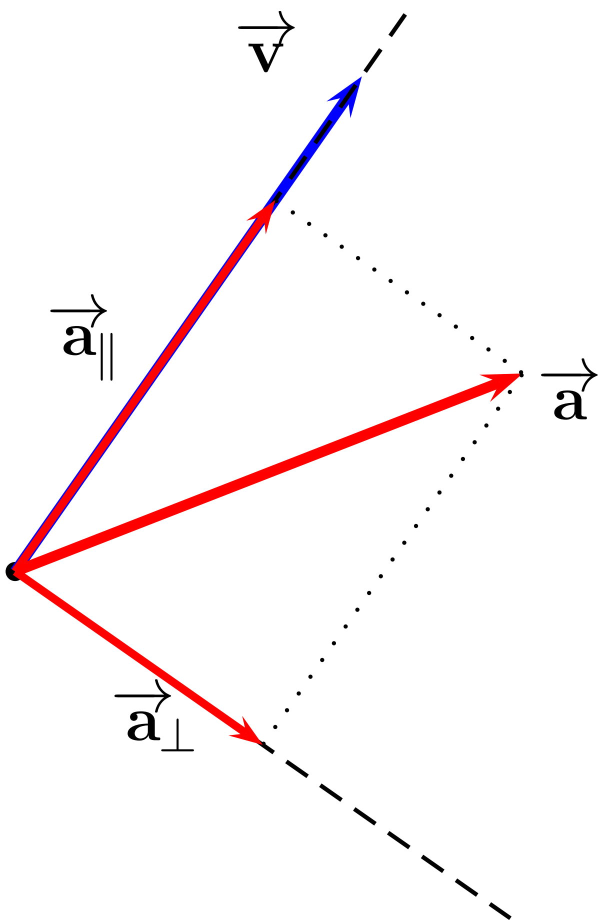
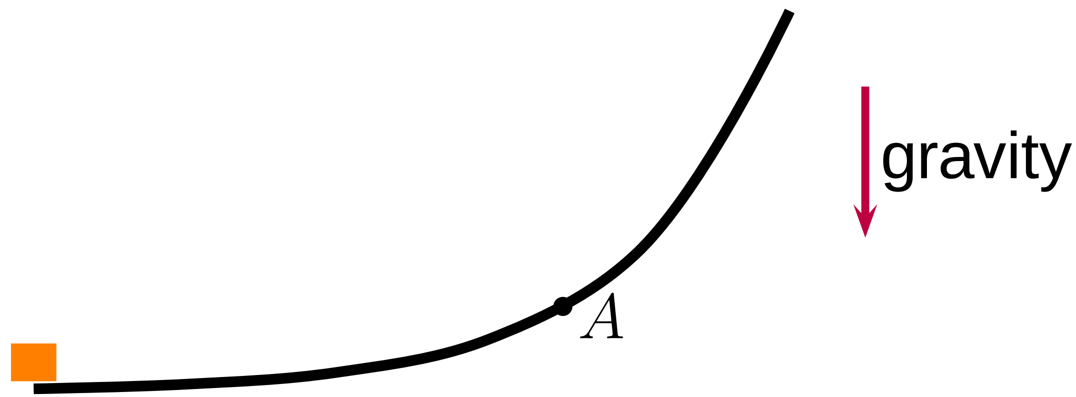


Split into components parallel and perpendicular to $\vec{\mathbf{v}}$

$\vec{\mathbf{a}}_{\parallel}$ changes speed
$\vec{\mathbf{a}}_{\perp}$ changes direction

Clicker Quiz

A mass slides up a ramp (against gravity) as shown.



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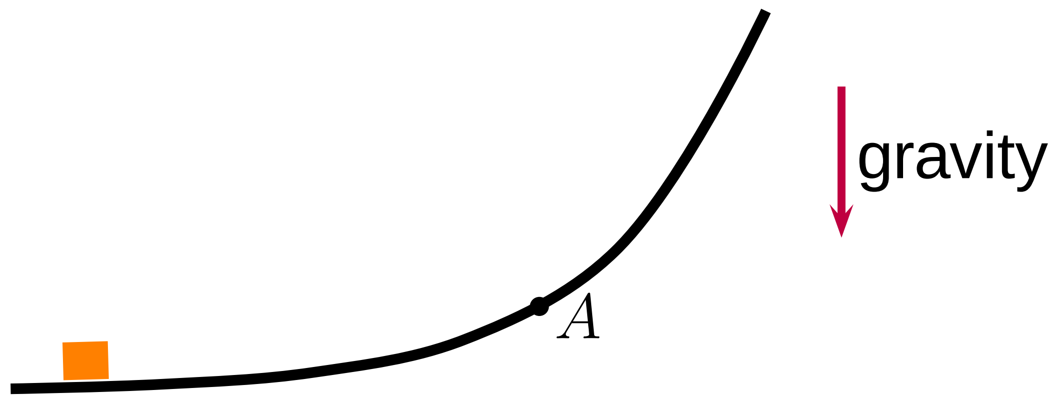

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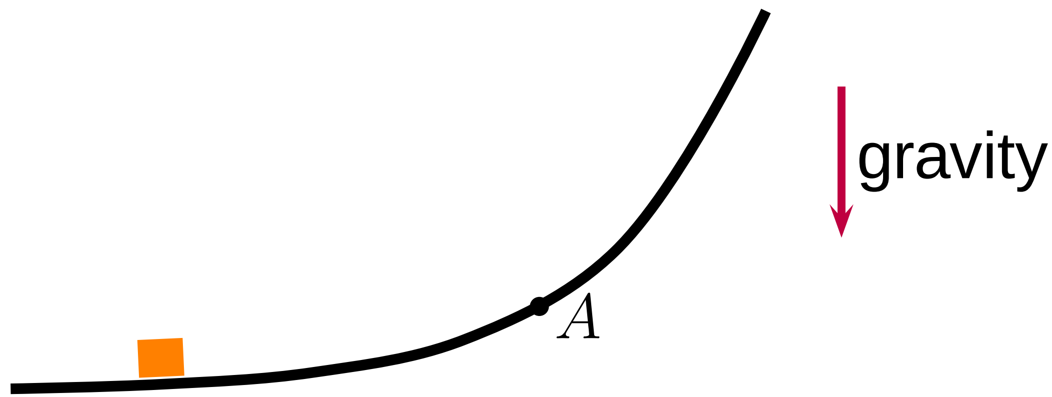

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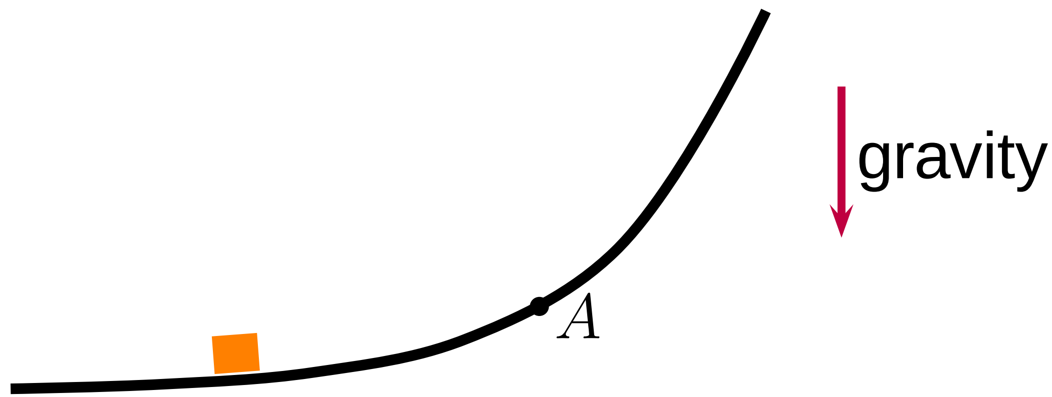

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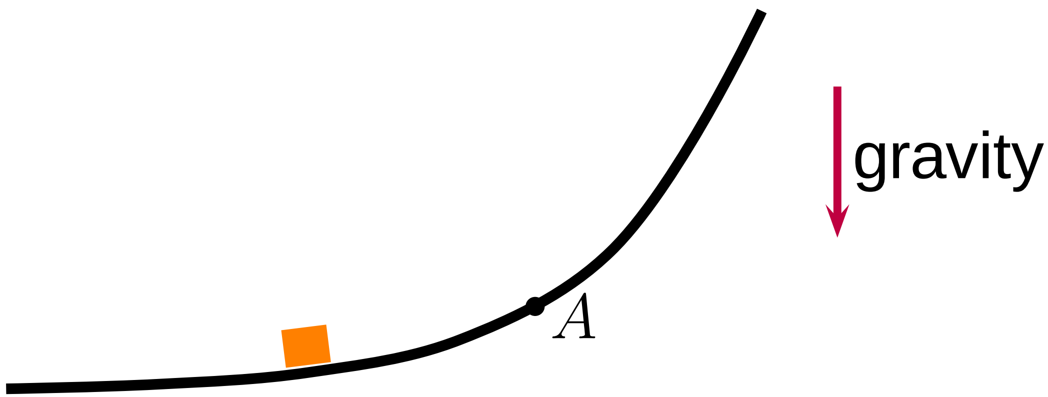

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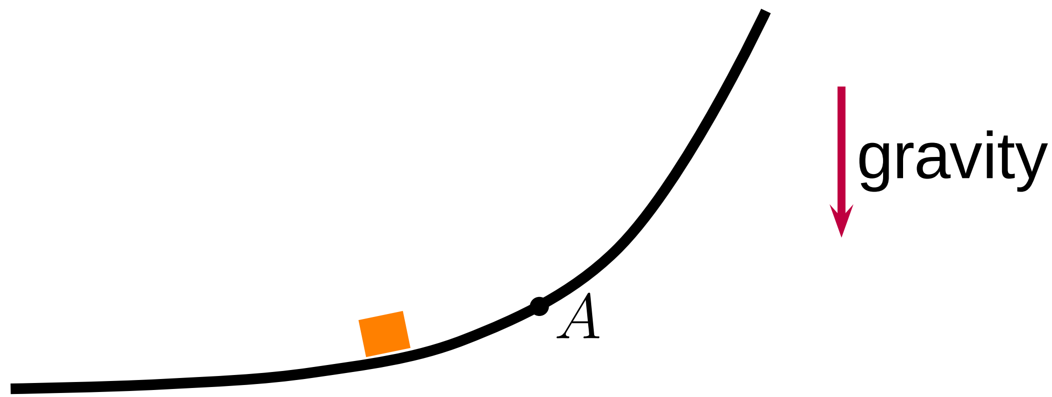

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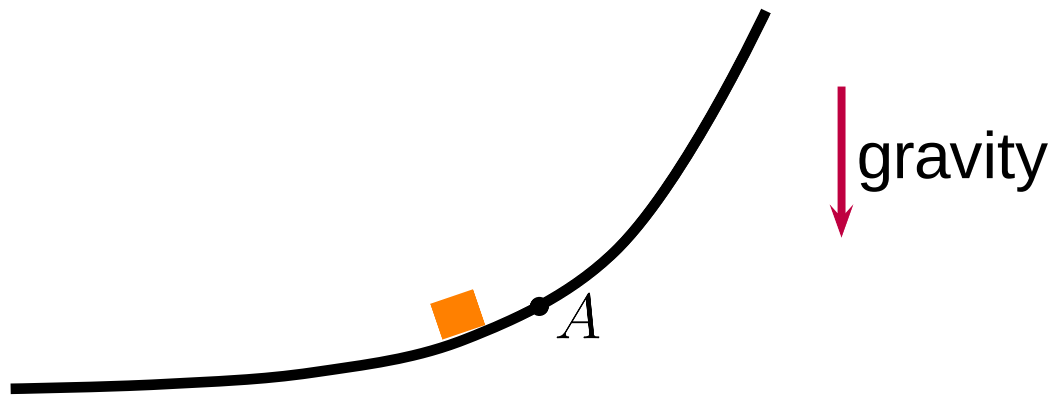

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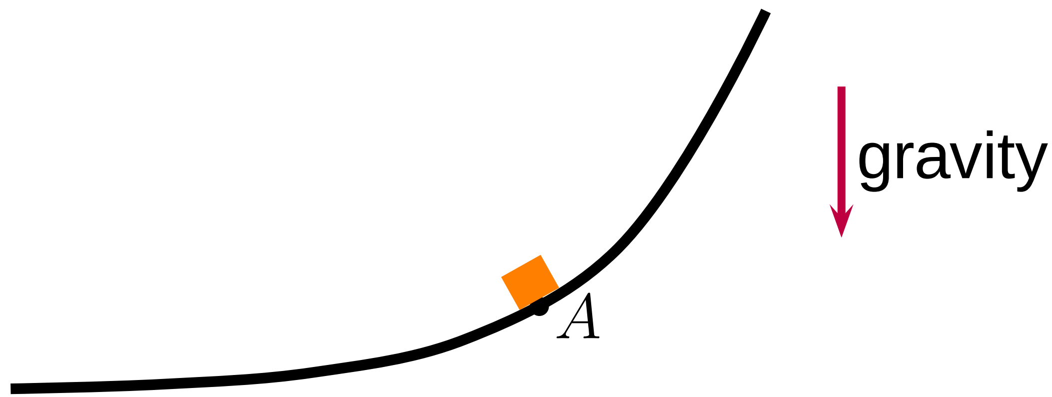

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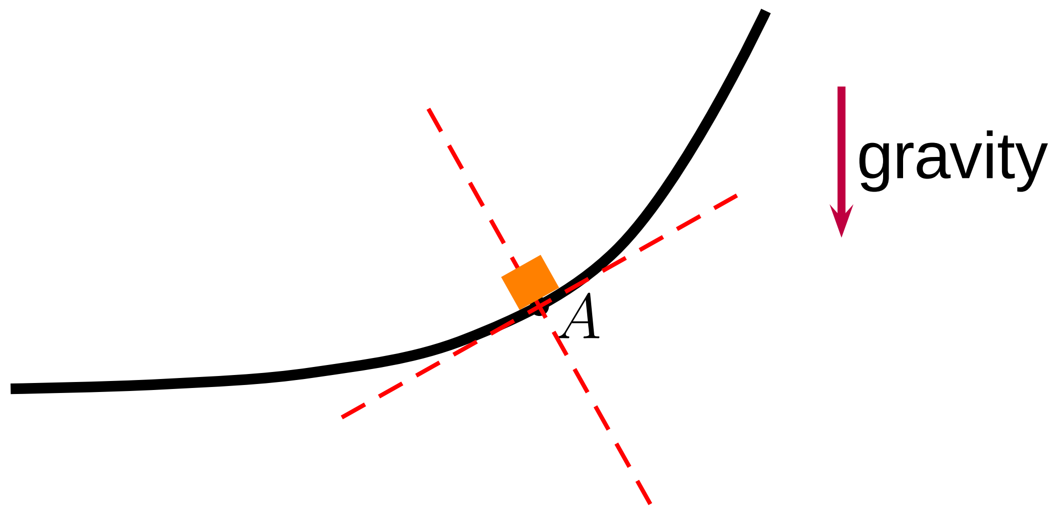

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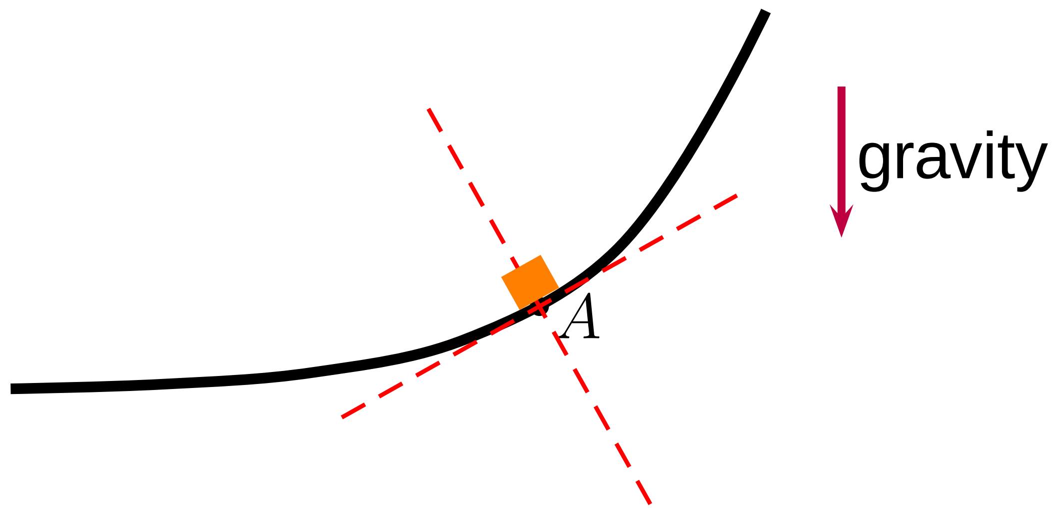

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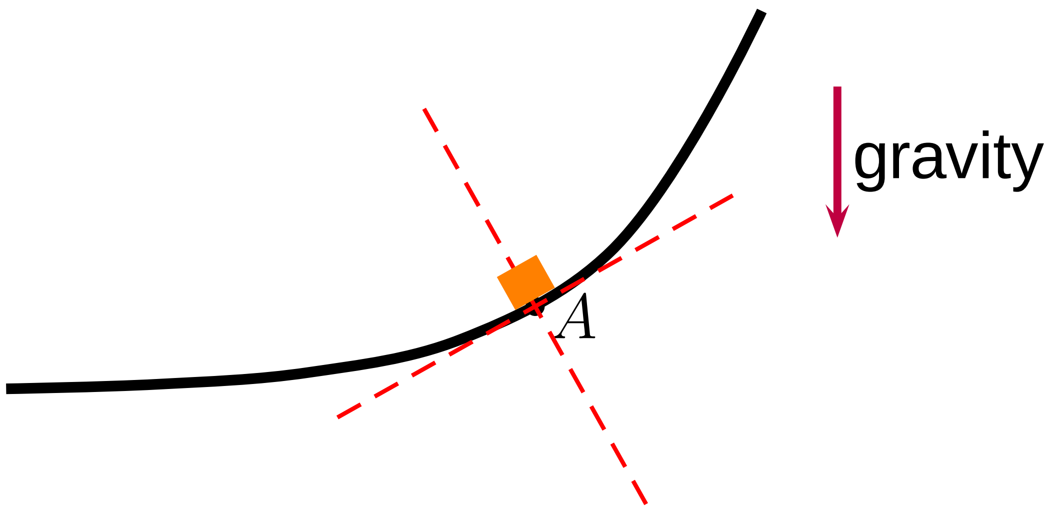

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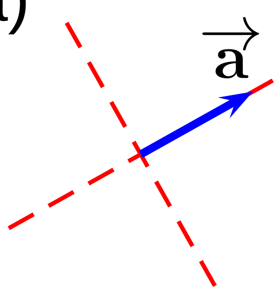

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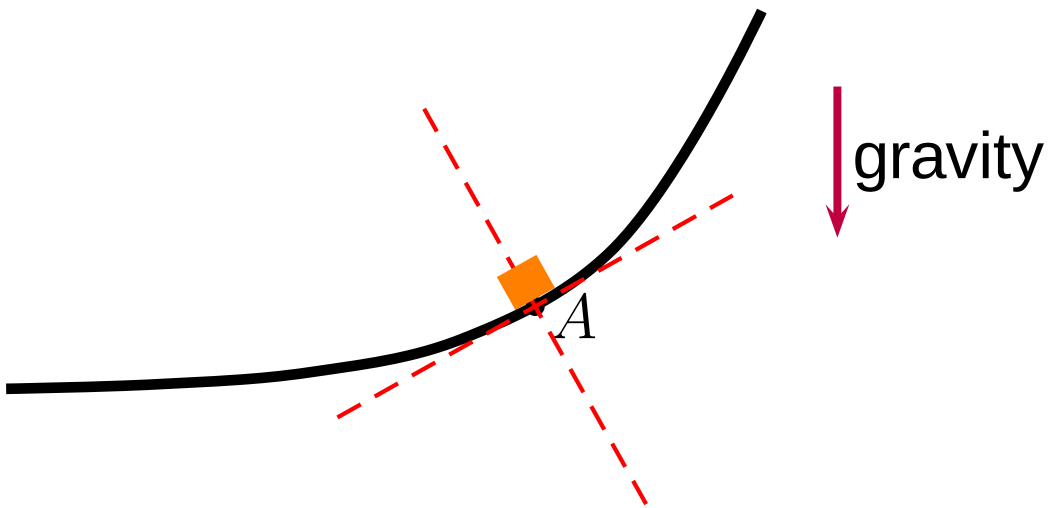

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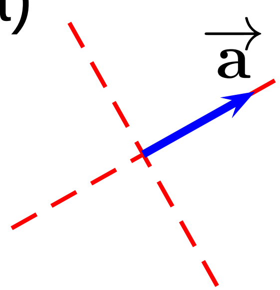

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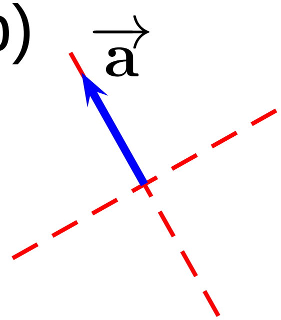

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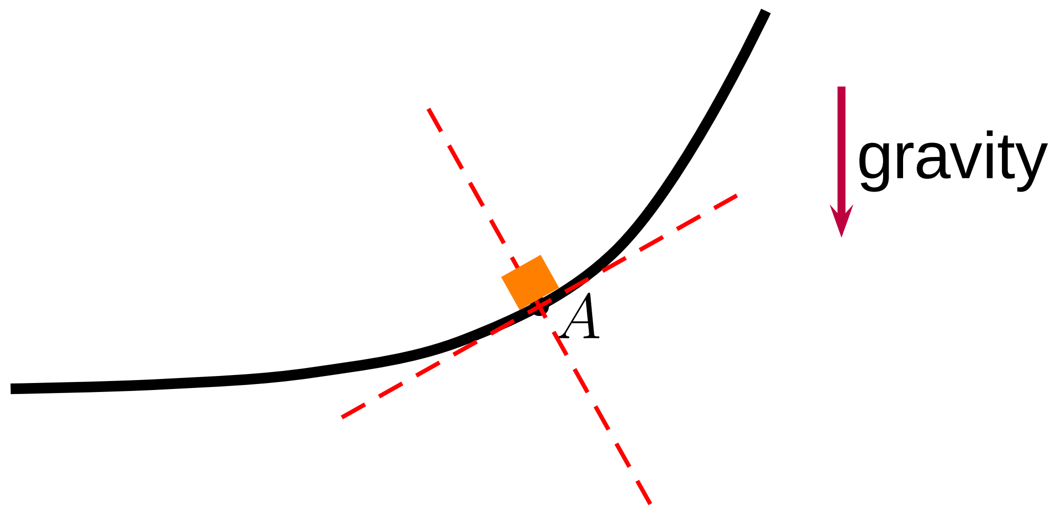

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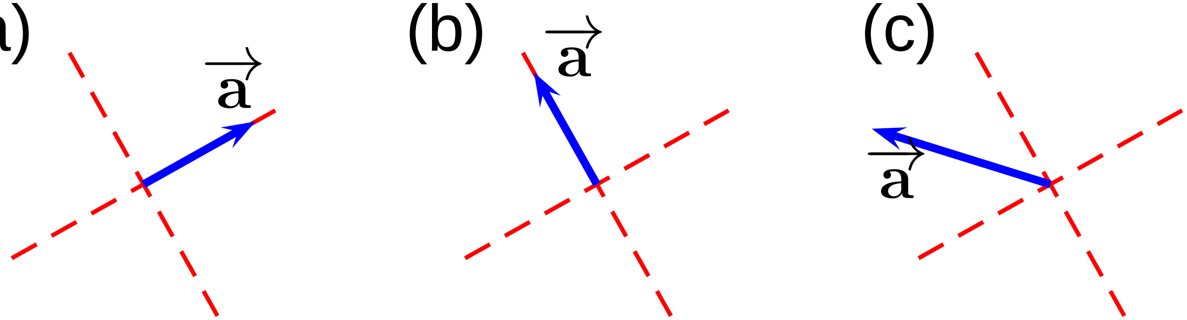

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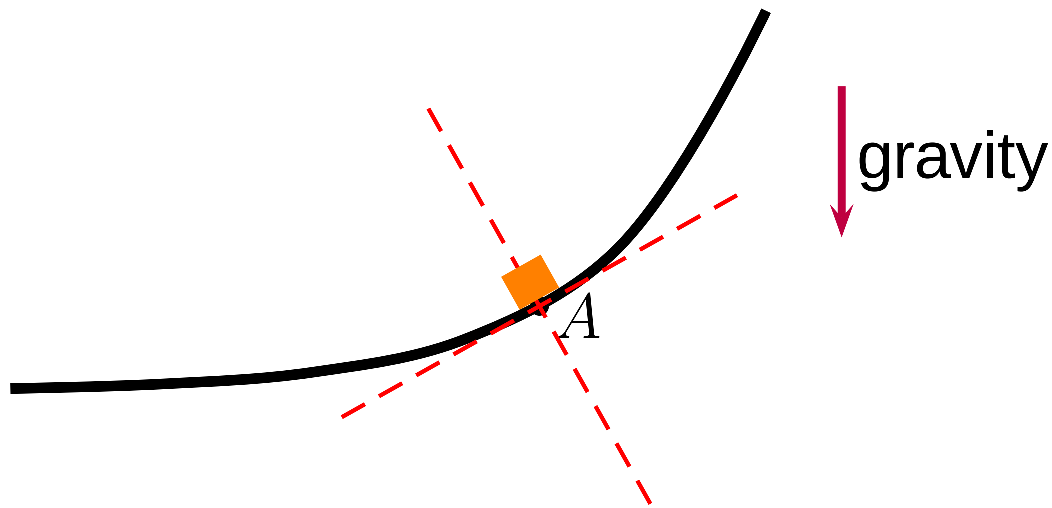

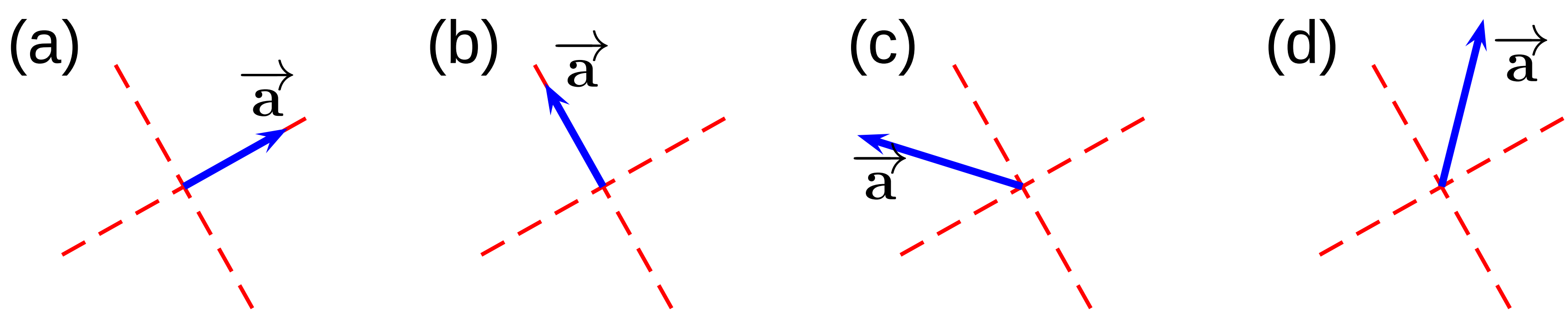

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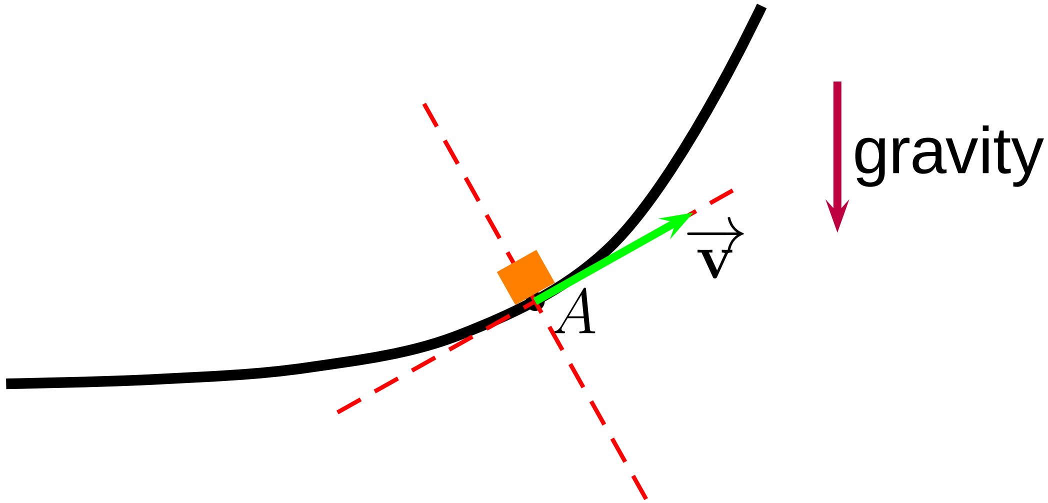

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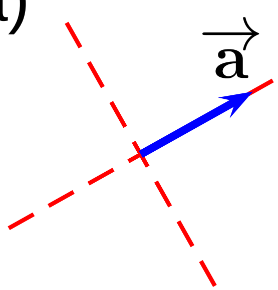

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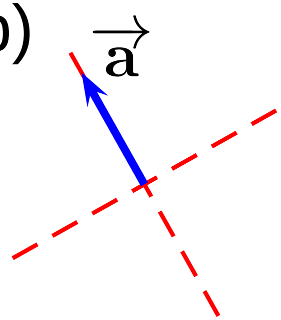

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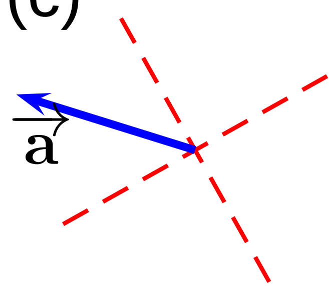

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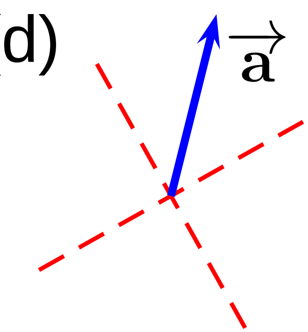

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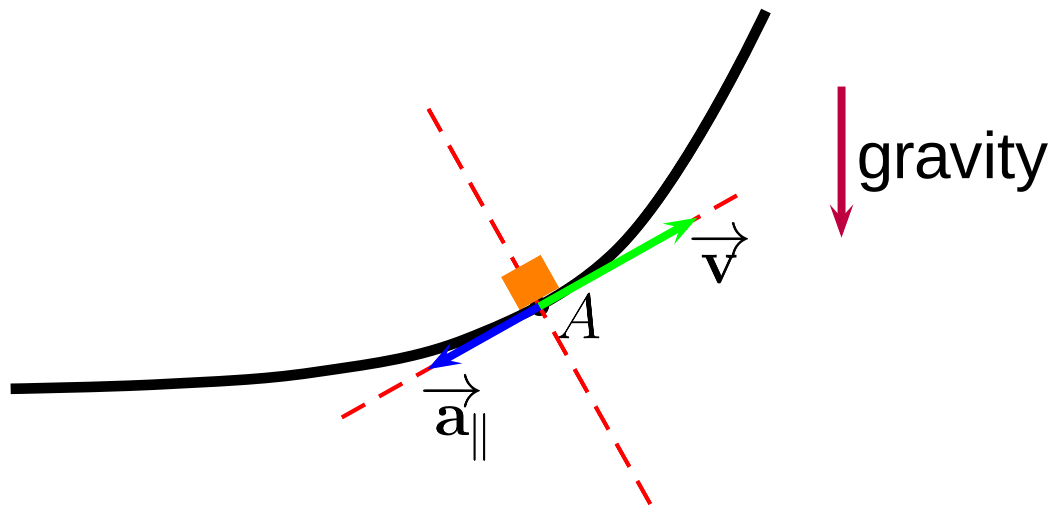

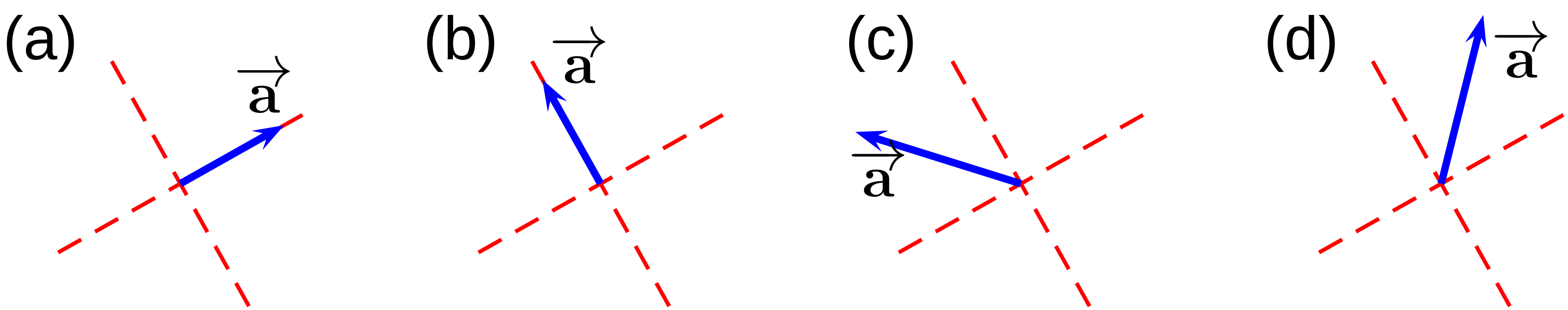

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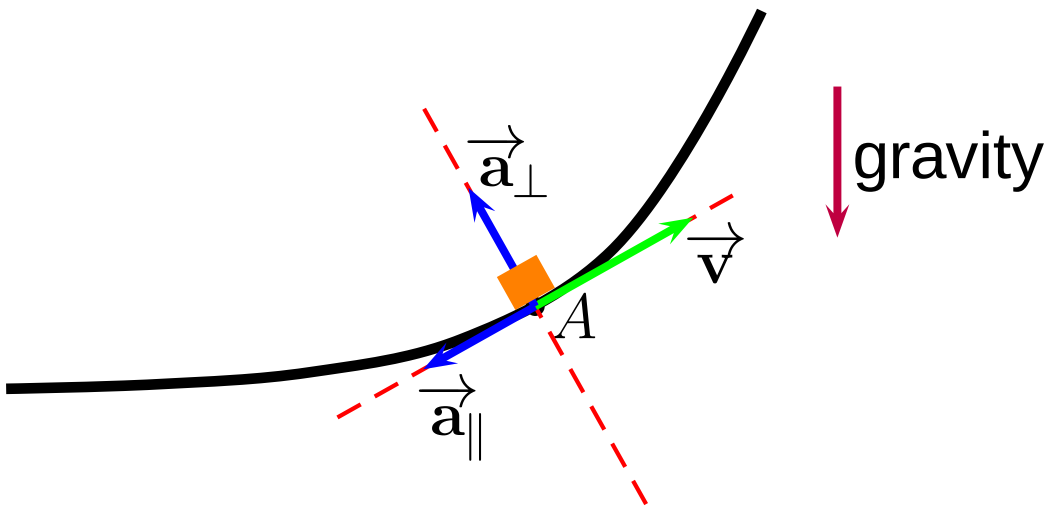

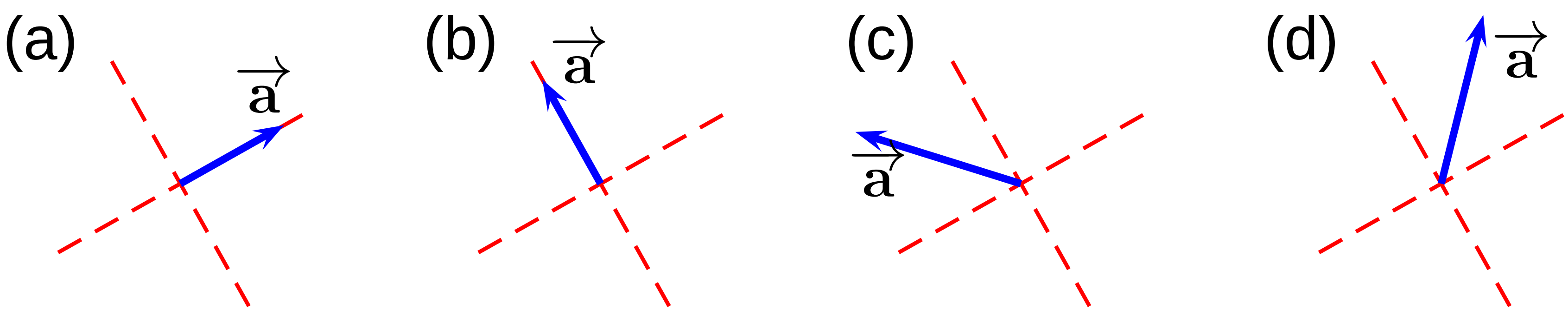

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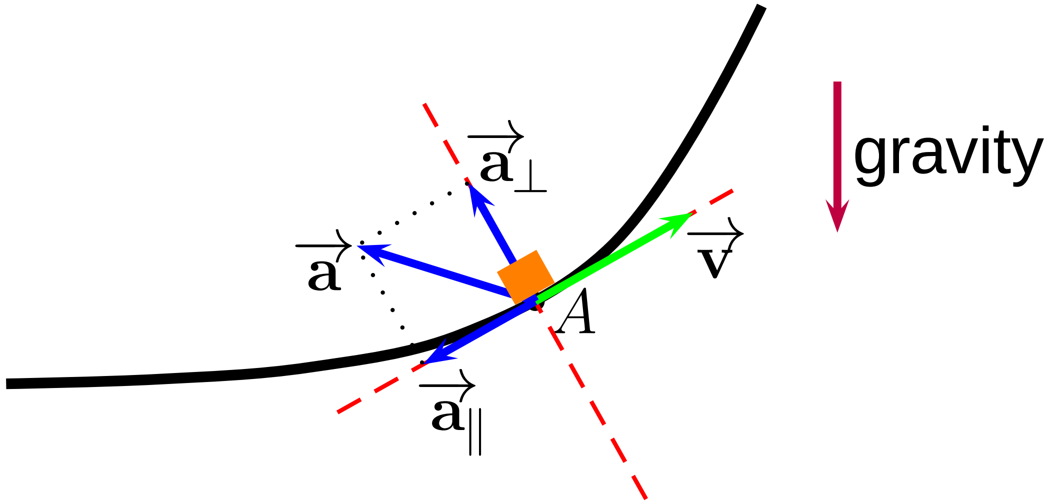

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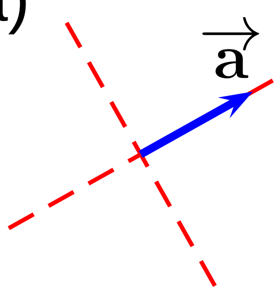

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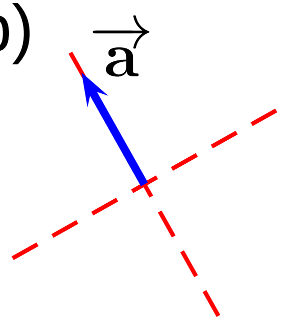

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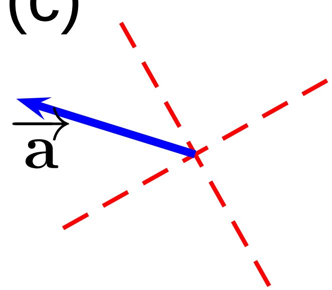

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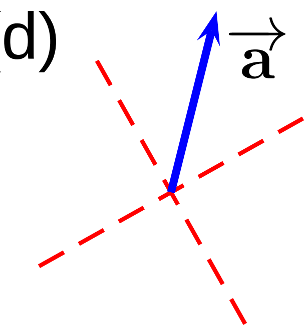

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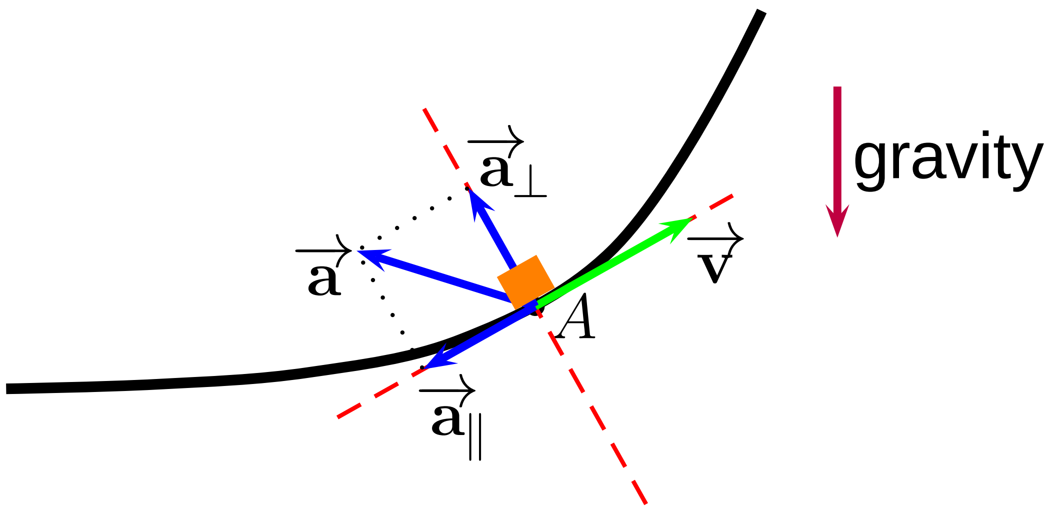
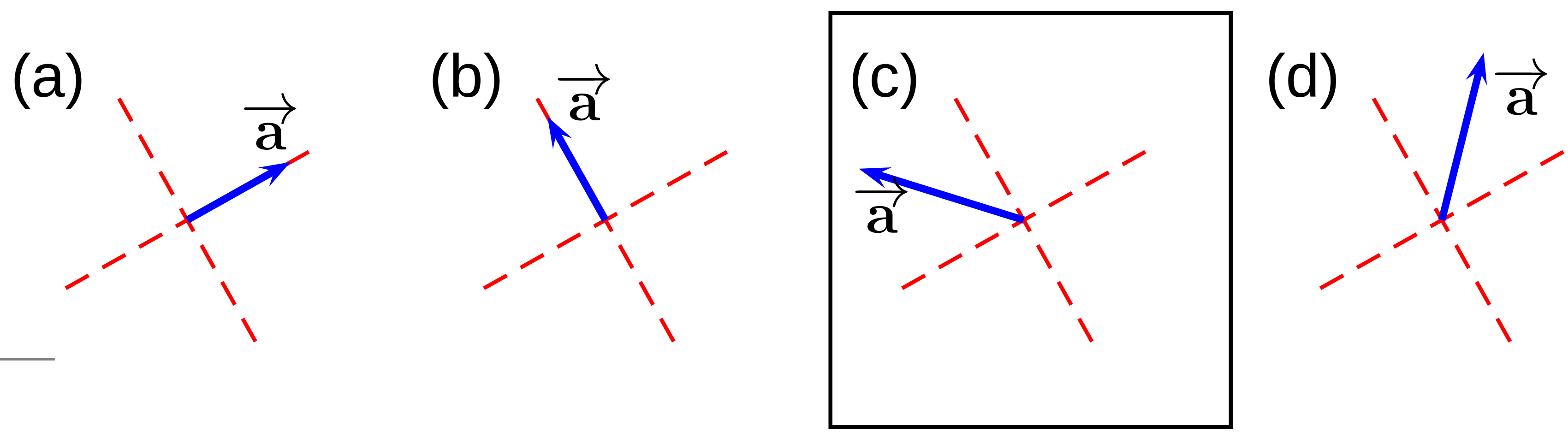
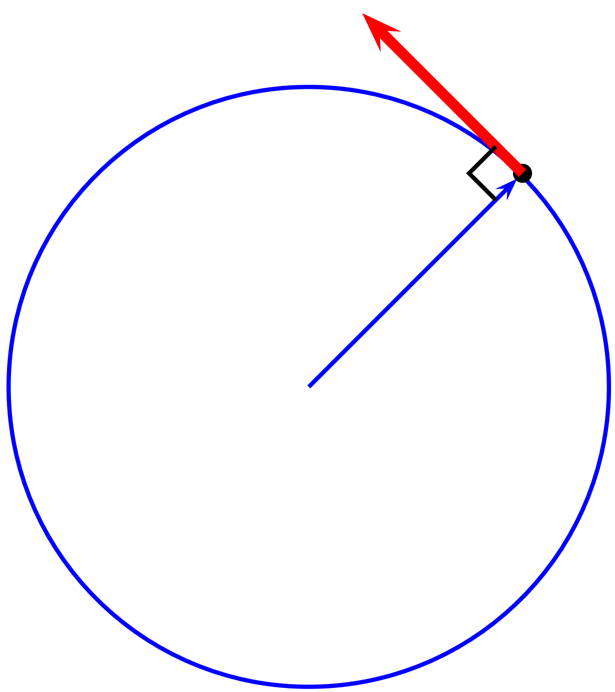




Uniform Circular Motion

An application of this idea is the problem of an object going around a circle with constant speed.

For circular motion, the velocity is tangent to the circle $\Rightarrow 90^\circ$ to the circle's radius.



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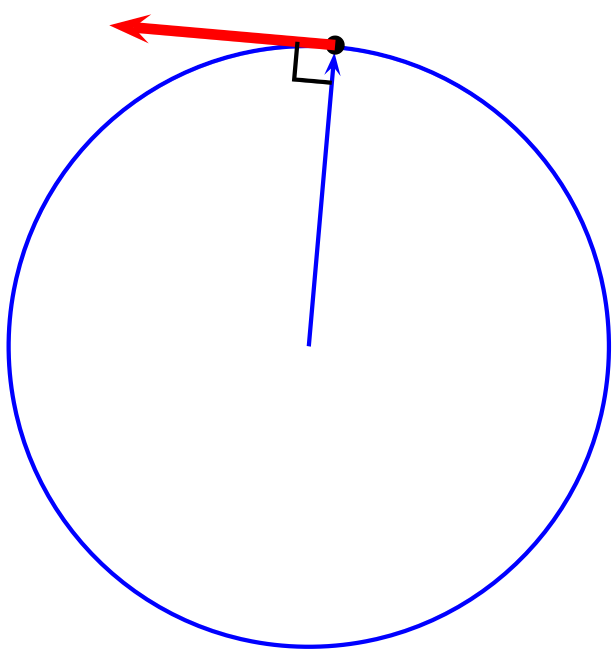

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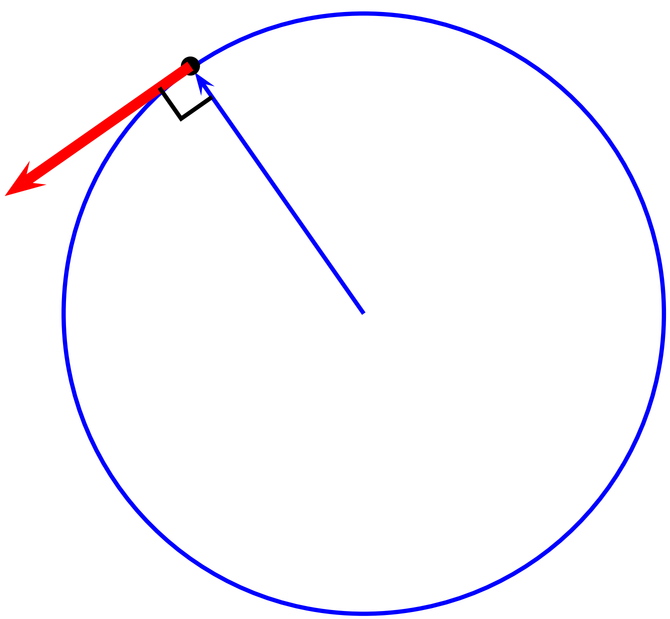

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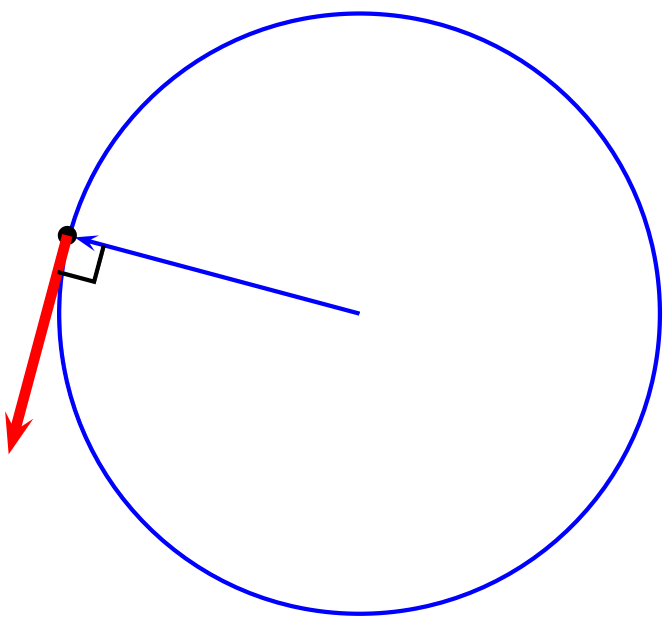

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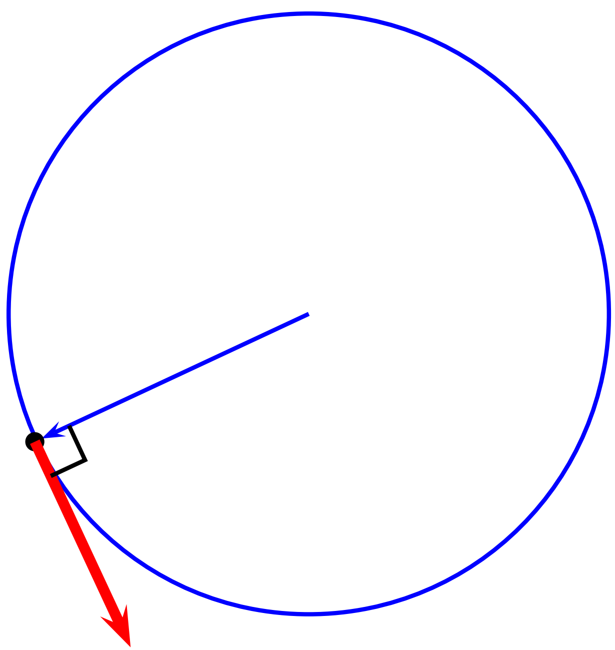

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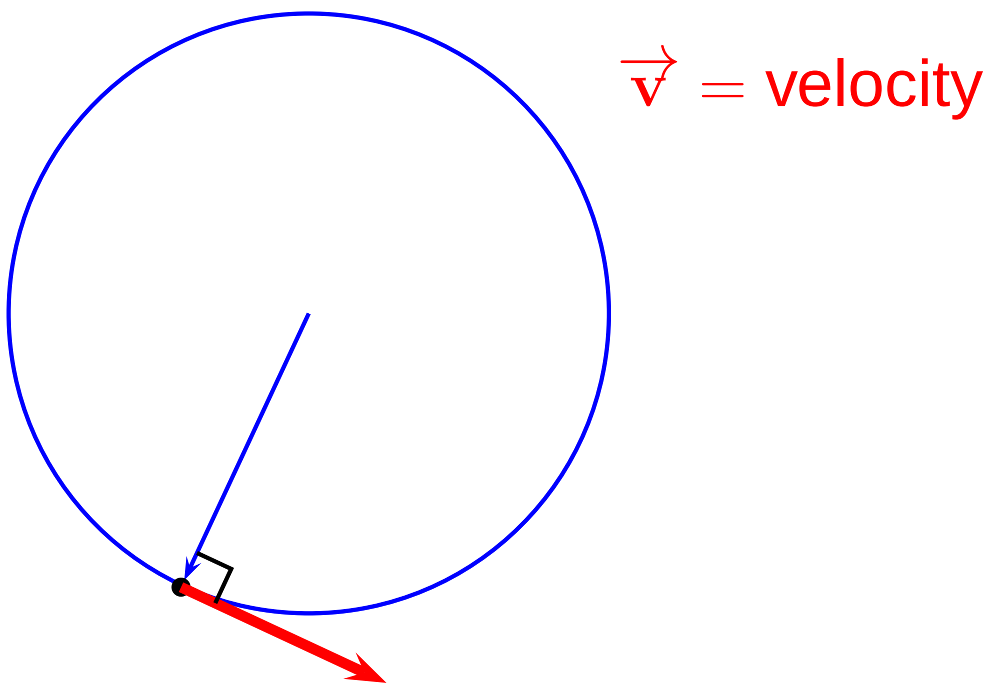

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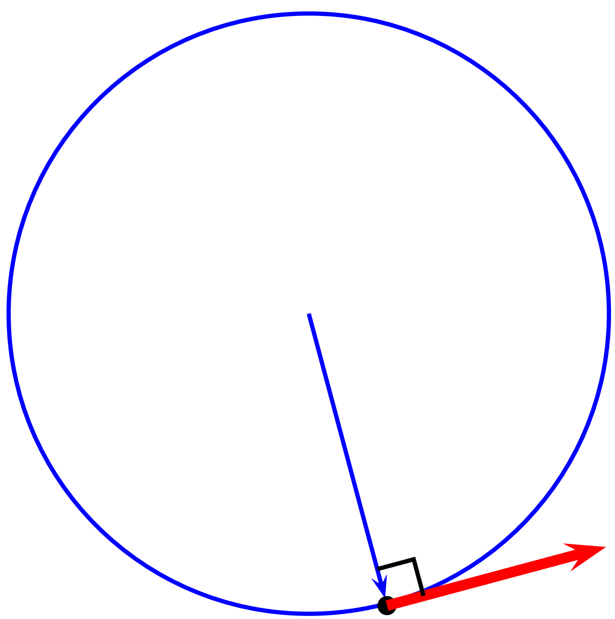

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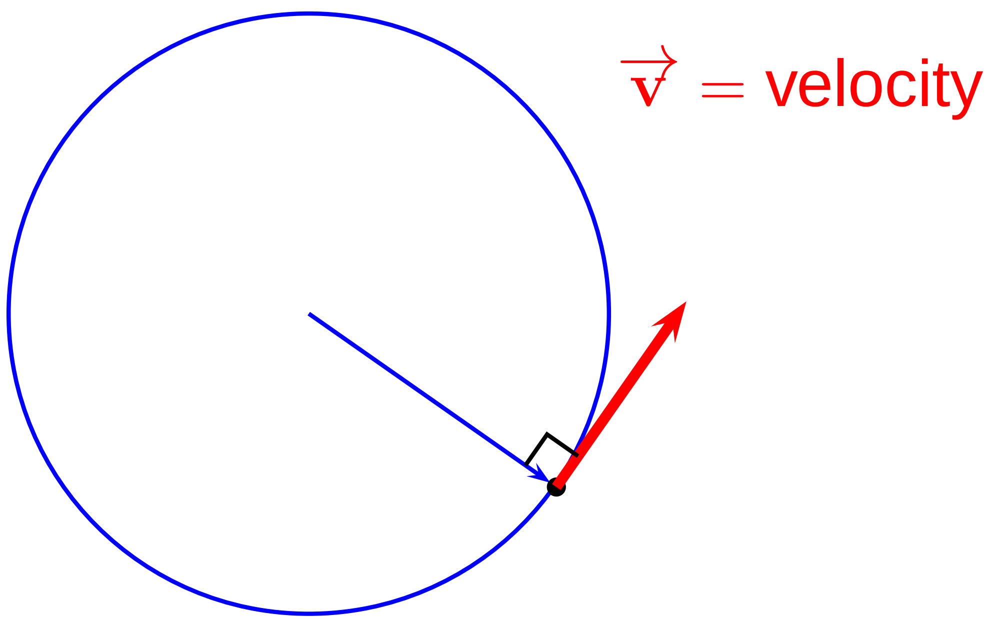

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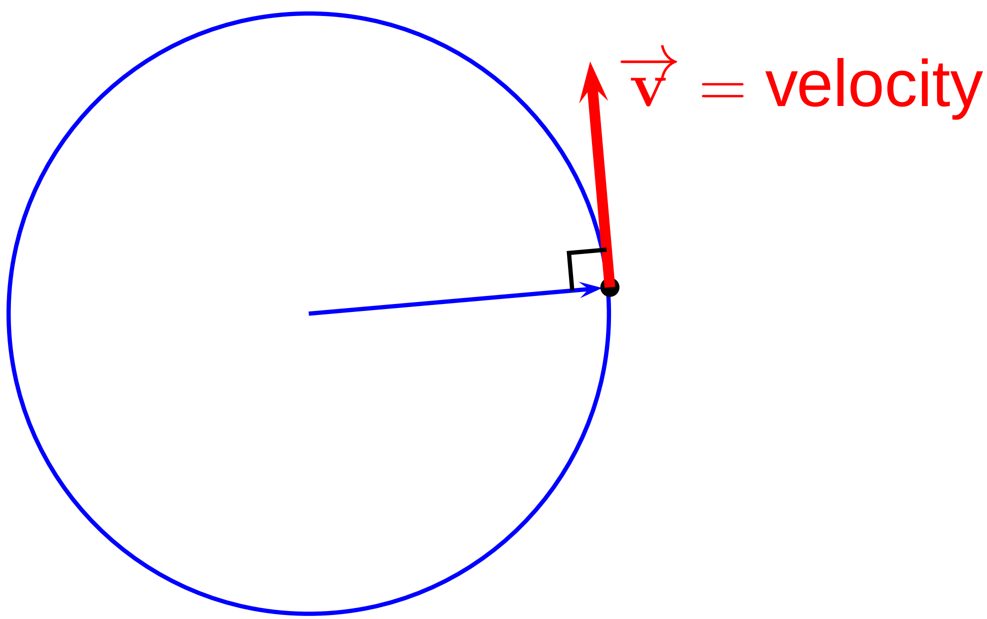
For circular motion, the velocity is tangent to the circle $\Rightarrow 90^\circ$ to the circle's radius.



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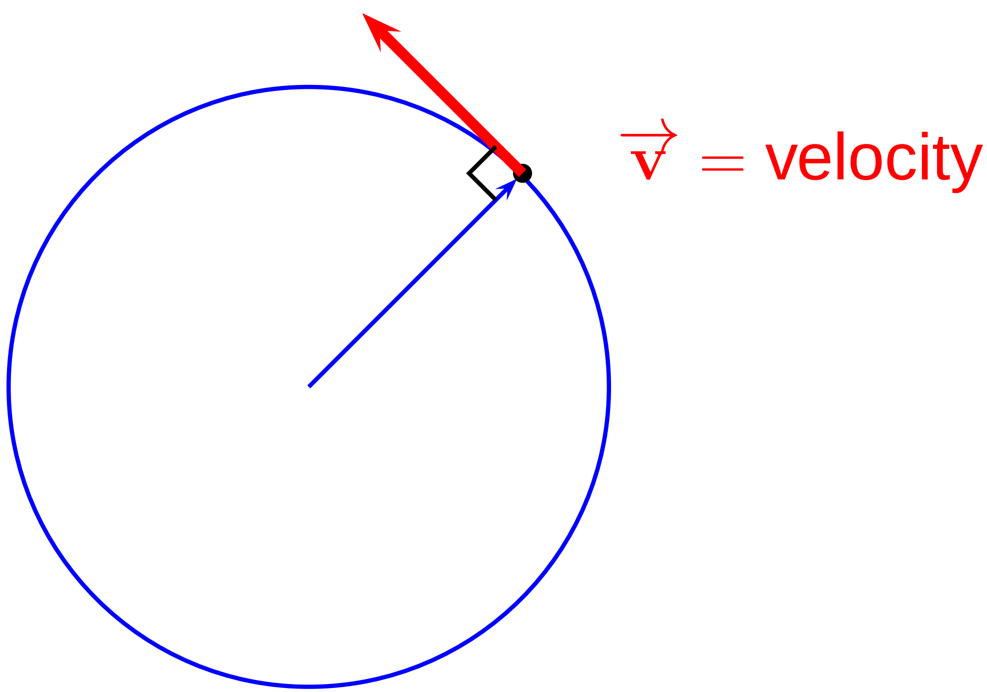

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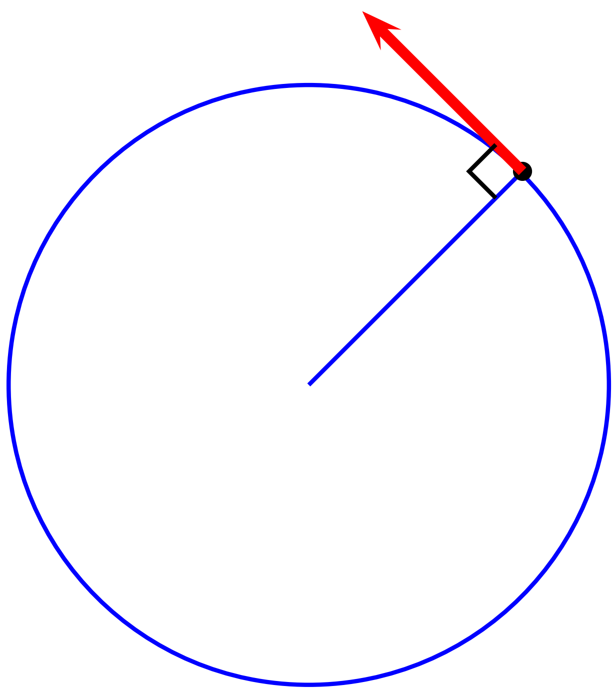
Centripetal Acceleration

The object's acceleration must always be perpendicular to the velocity.



$\vec{\mathbf{v}}$

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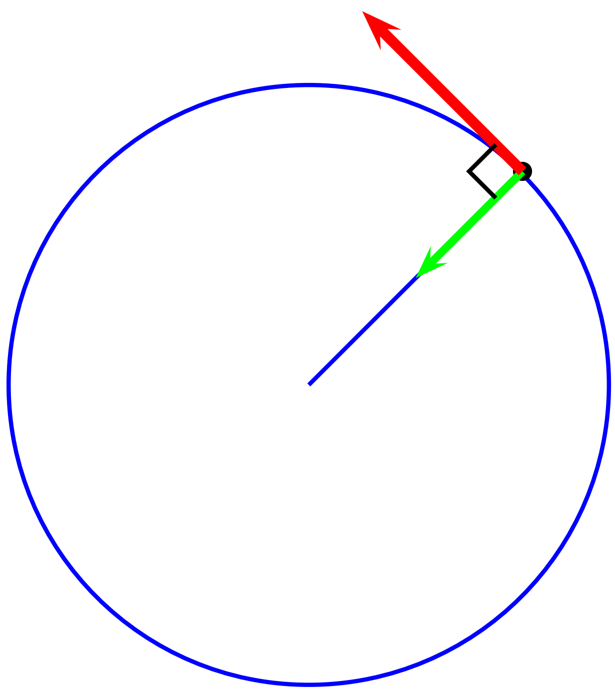

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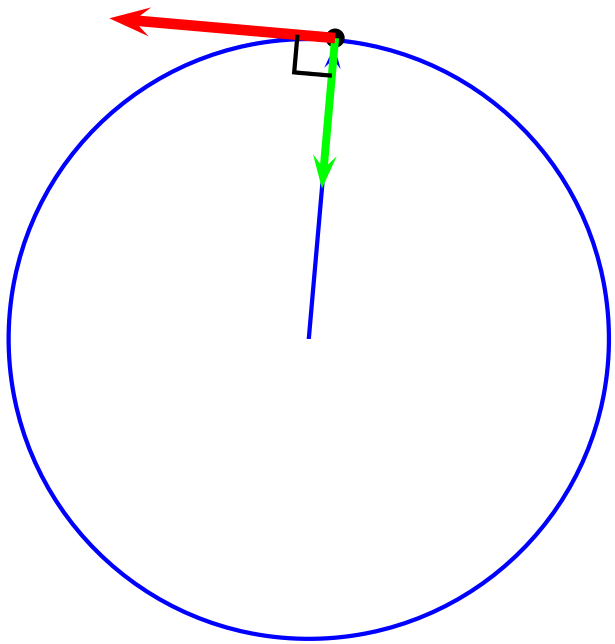

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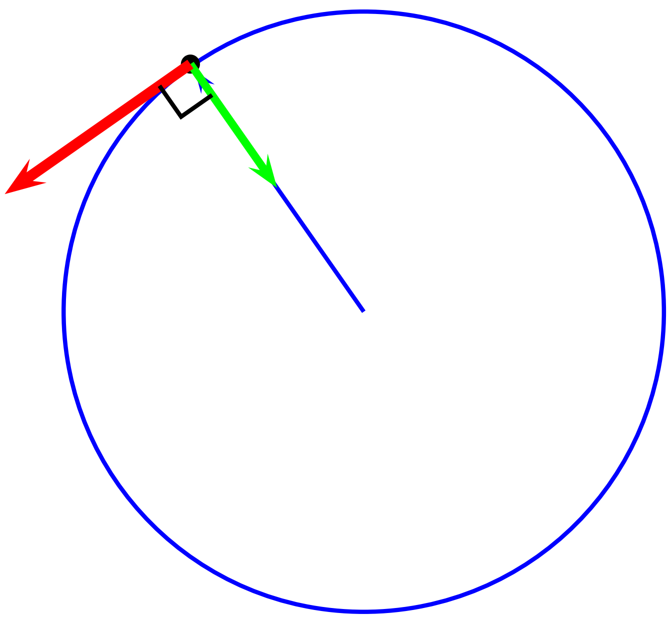

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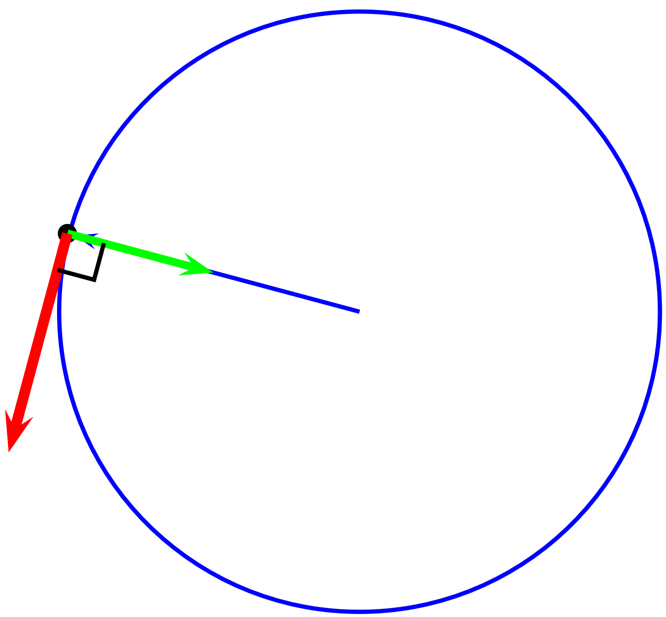

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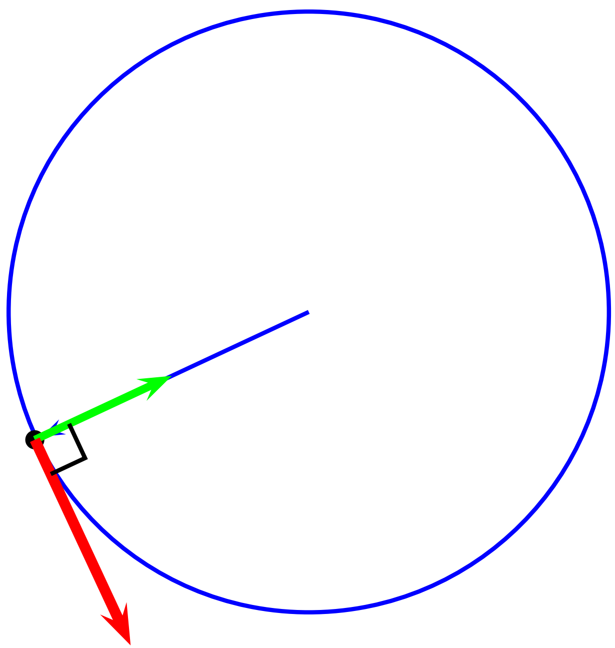

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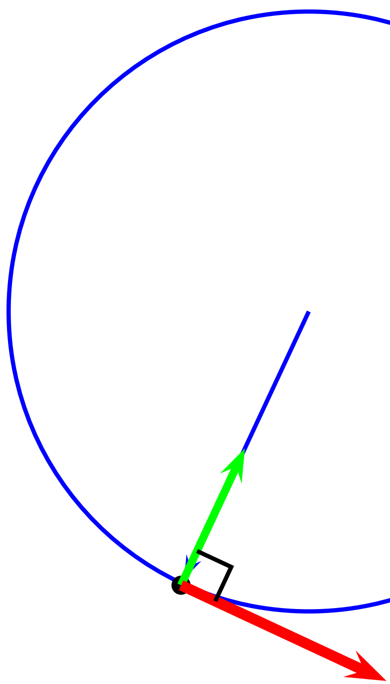

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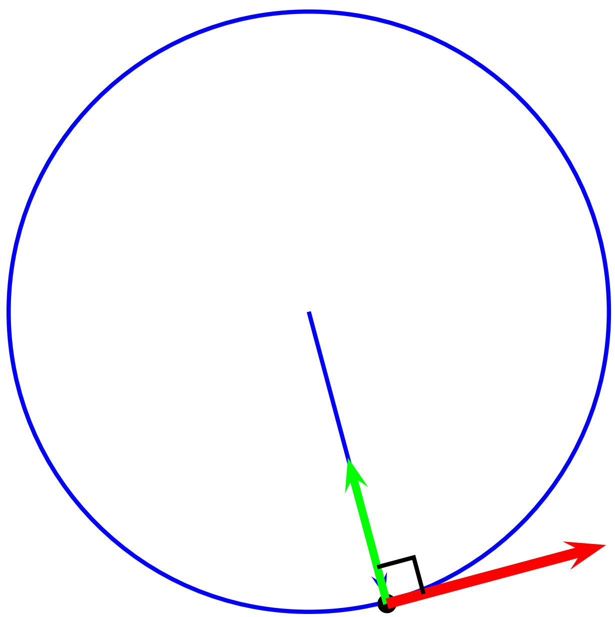

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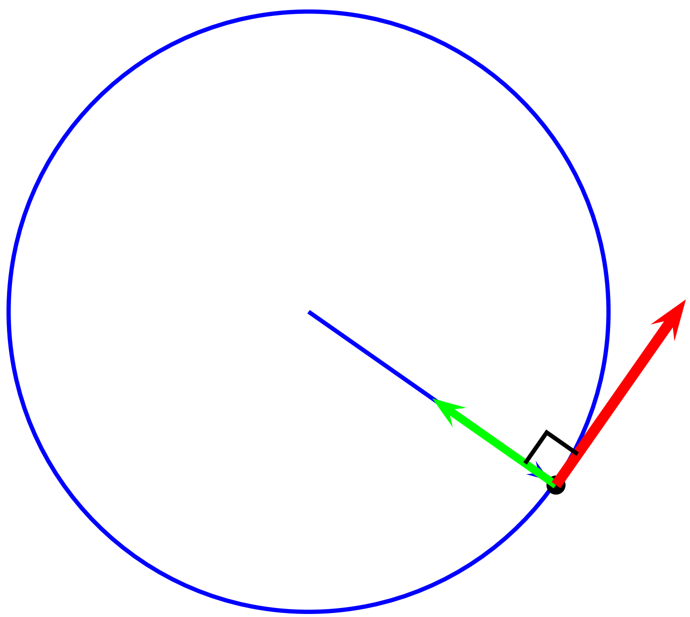

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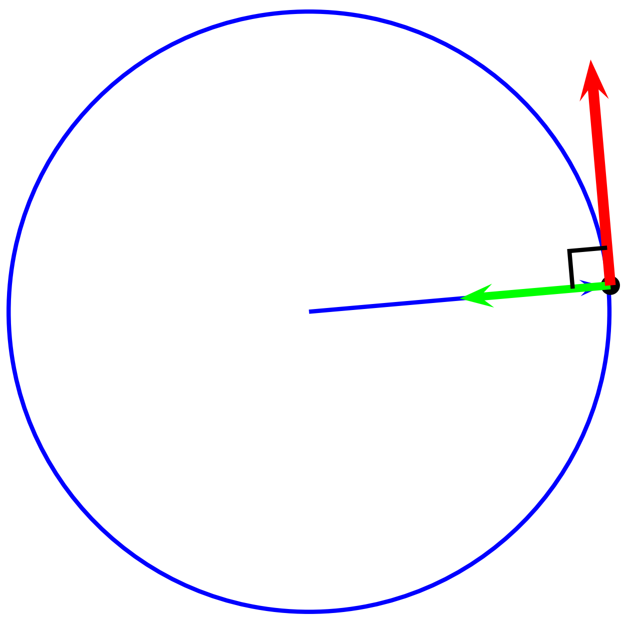

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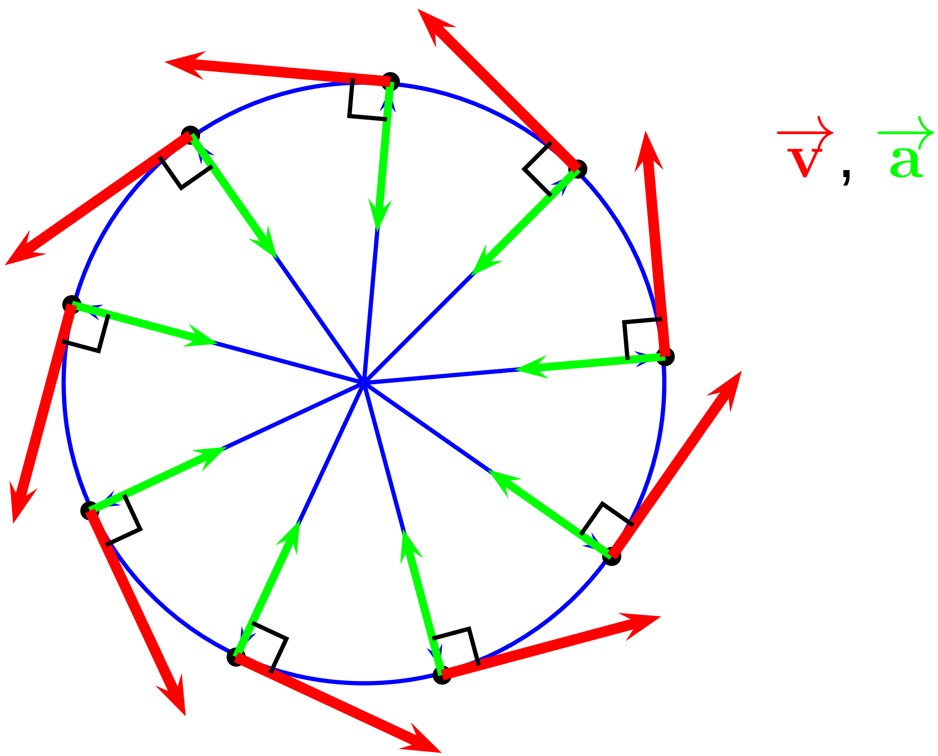

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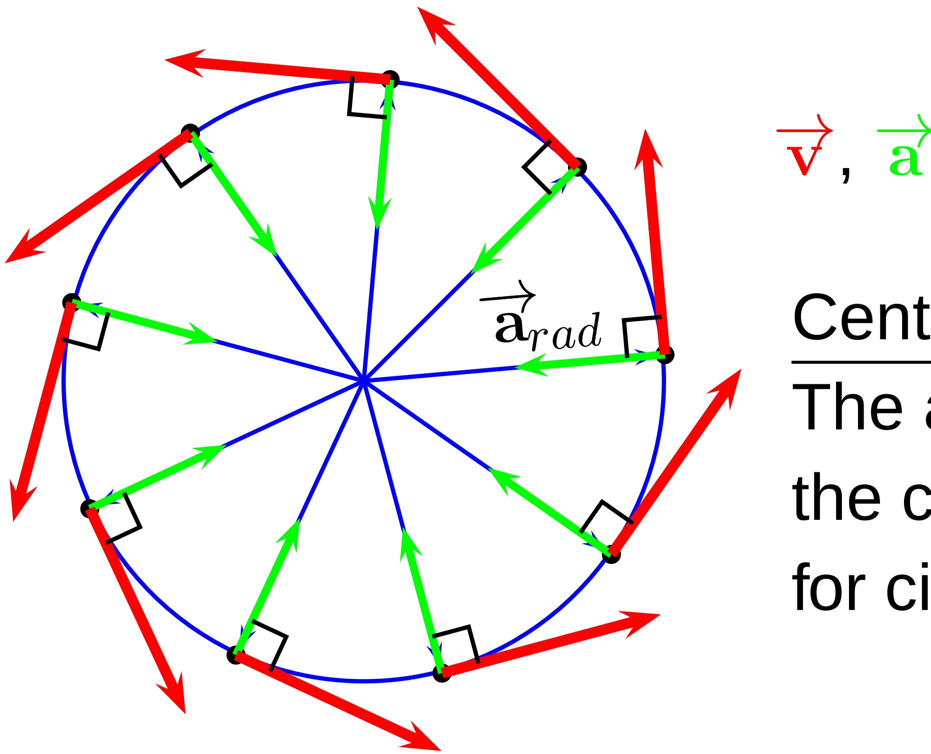
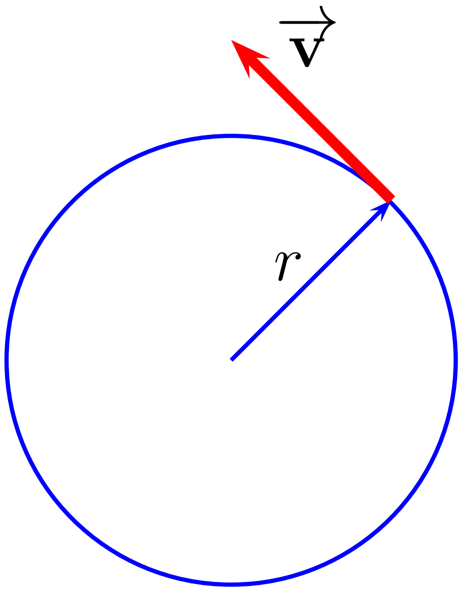


Centripetal Acceleration - $\vec{a}_{rad}$
The acceleration towards the center necessary for circular motion

Centripetal Acceleration II



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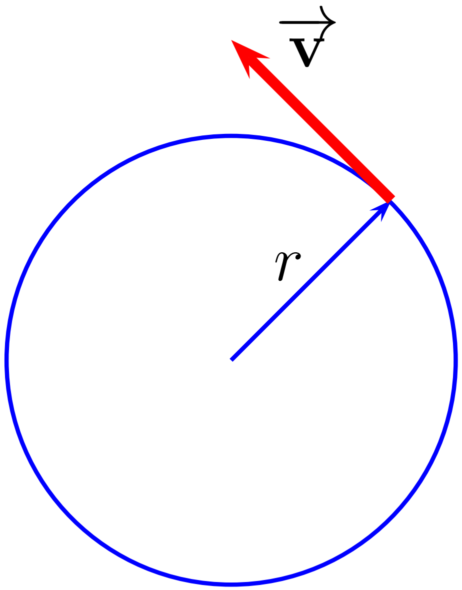

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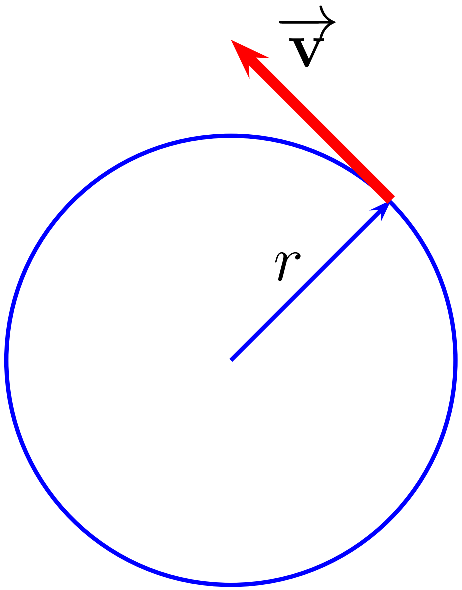

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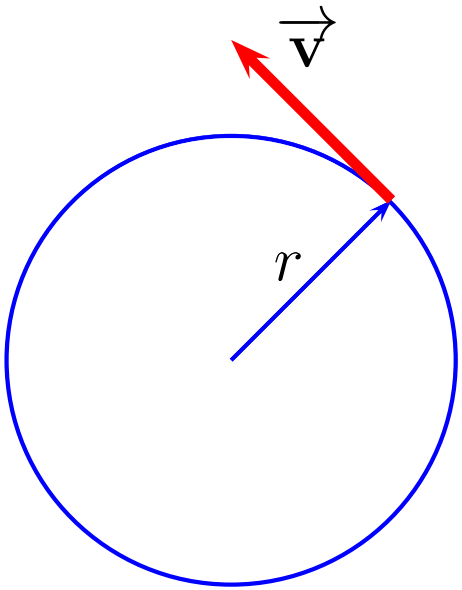

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$$T = \frac{2\pi r}{v} \Rightarrow a_{rad} = \frac{4\pi^2 r}{T^2}$$

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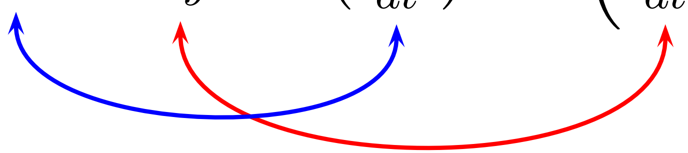

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Initial Velocity Vector: $\overrightarrow{\mathbf{v}}_o = v_{o,x} \hat{\boldsymbol{\imath}} + v_{o,y} \hat{\boldsymbol{\jmath}}$

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Position Vector: $\overrightarrow{\mathbf{r}} = x\hat{\boldsymbol{\imath}} + y\hat{\boldsymbol{\jmath}}$

Initial Position Vector: $\overrightarrow{\mathbf{r}}_o = x_o\hat{\boldsymbol{\imath}} + y_o\hat{\boldsymbol{\jmath}}$

Example

$$x = x_o + v_{o,x}t + \frac{1}{2}a_x t^2, \quad v_x = v_{o,x} + a_x t$$

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Example: A car is traveling east at $20\,m/s$ when it is hit by a truck going north. If the collision causes a constant acceleration of $5\,m/s^2$ to the north, and the car's brakes a constant deceleration of $3\,m/s^2$ to the west, where is the car located after 3s?

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- What direction is the car moving in at that point in time?