02 Force Vectors

Engineering Statics

Updated on: August 20, 2025

Scalars versus Vectors

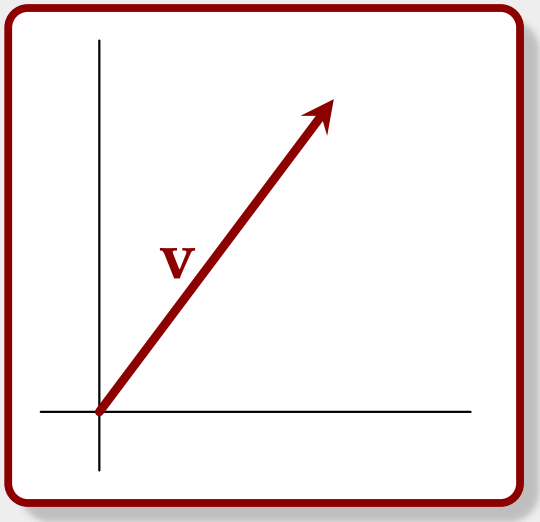
- Physical quantities in this course are measured using either **scalars** or **vectors**.
- A scalar quantity can be fully specified by its **magnitude** (or size) and units alone.

  Examples are temperature, speed, mass, time, length, volume, density and energy.
- A vector quantity requires both magnitude **and direction** - in addition to units - to be fully specified.

  Examples are displacement, velocity, force and momentum.
- 110 km/h is a speed. 110 km/h in a north-easterly direction is a vector.
- The vector quantity that is of most interest to us is **force**.

Graphical Vector Representation

- To represent a vector on a diagram, we draw a directed line segment – a line with an arrow tip.
- The length of the line segment is proportional to the magnitude of the vector.
- The direction of the line segment shows the direction of the vector.
- The arrow head gives the sense of that direction (up and rightwards in this case).



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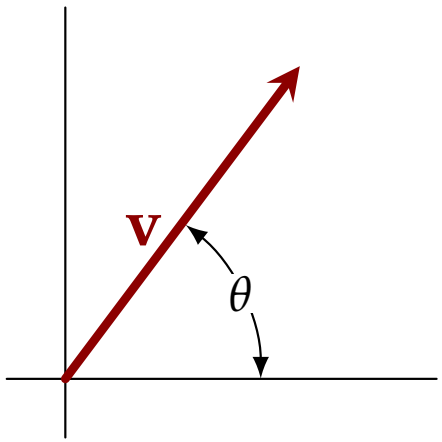
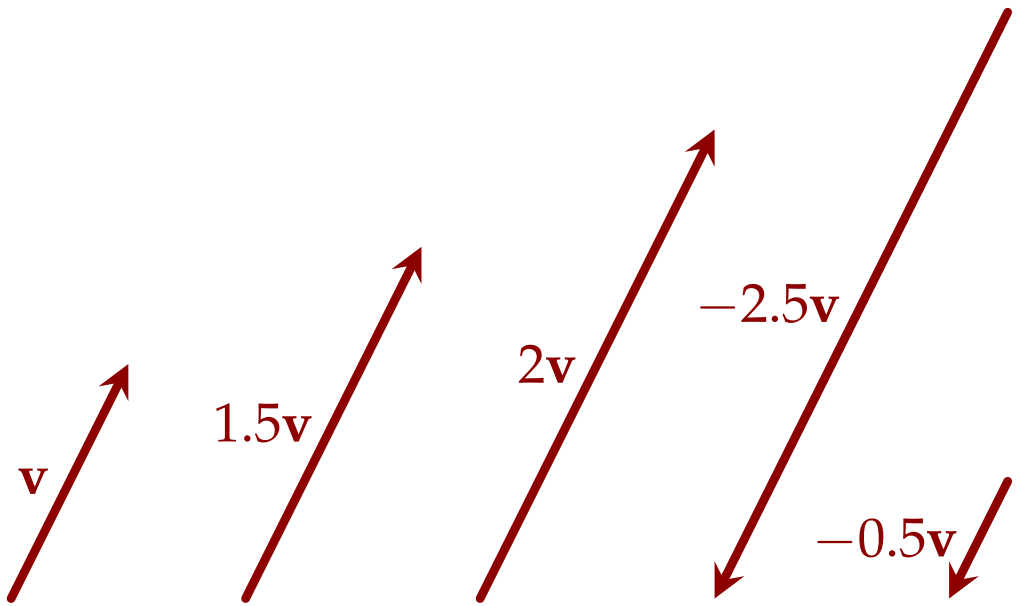


- θ indicates the direction of the line of action of the vector $\mathbf{v}$ relative to some reference.
  (I.e., the horizontal axis in this case.)

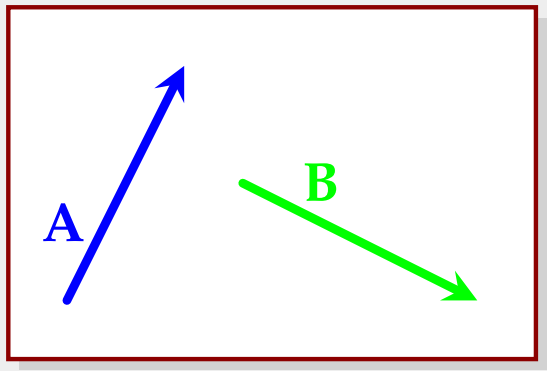
Multiplication of a vector by a scalar

Multiplication of a vector by a scalar affects the magnitude and, if the scalar is negative, the sense of the direction of the vector.



Addition of Vectors

Consider two vectors, $\mathbf{A}$ and $\mathbf{B}$:



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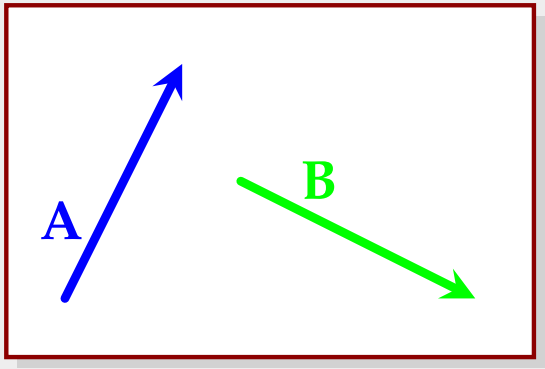
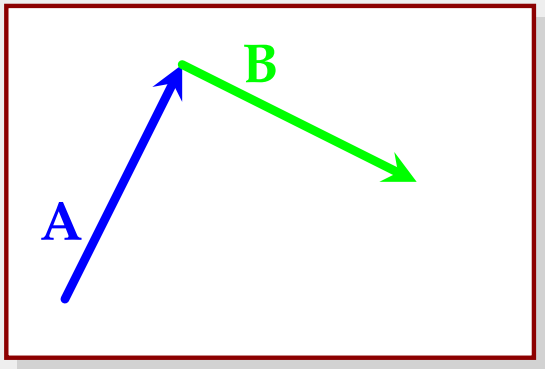


To add vectors $\mathbf{A}$ and $\mathbf{B}$, written $\mathbf{A} + \mathbf{B}$, place the tail of $\mathbf{B}$ at the tip of $\mathbf{A}$.



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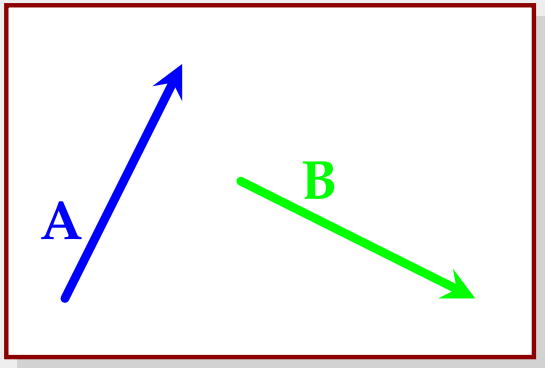

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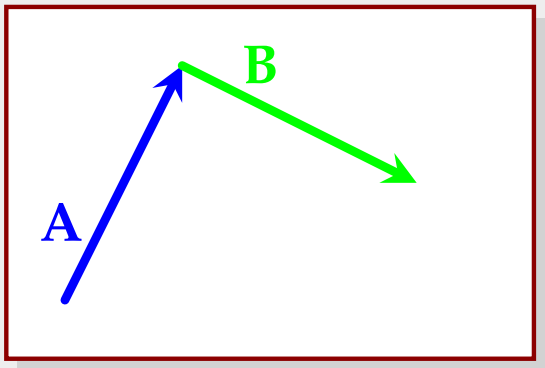
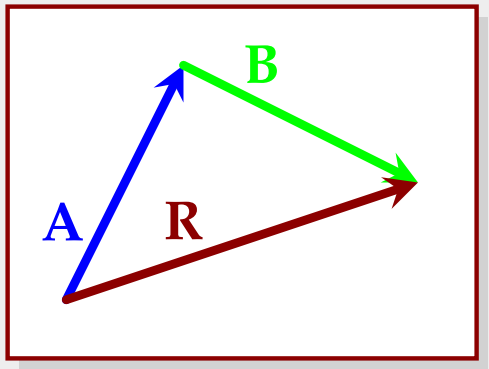


The sum, $A + B$, is obtained by drawing a vector $\boldsymbol{R}$ from the tail of $\mathbf{A}$ to the tip of $\mathbf{B}$.

$$\mathbf{A} + \mathbf{B} = \mathbf{R}$$



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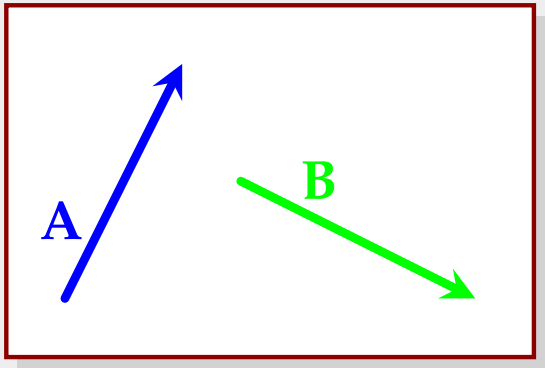

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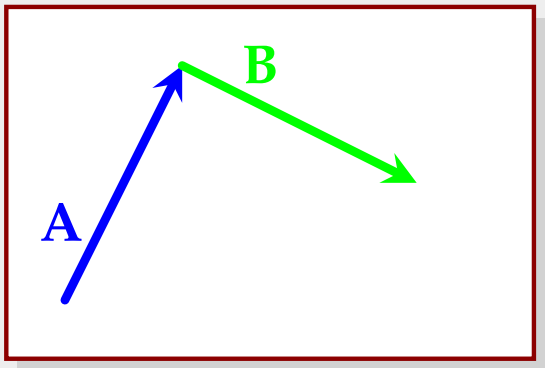

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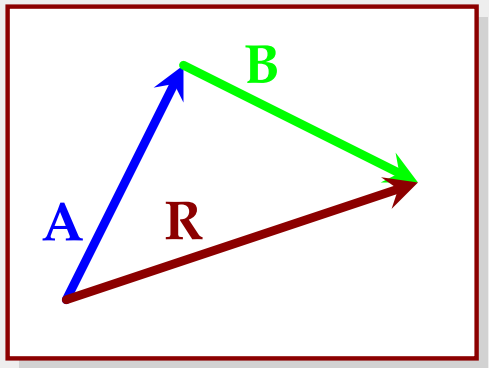

Note that the sum of two vectors is itself a vector.