Chapter 3
Kinematics in Two Dimensions; Vectors

3-1 Vectors and Scalars
A vector has magnitude as well as direction.
Some vector quantities: displacement, velocity, force, momentum
A scalar has only a magnitude.
Some scalar quantities: mass, time, temperature

3-2 Addition of Vectors – Graphical Methods
For vectors in one dimension, simple addition and subtraction are all that is needed.
You do need to be careful about the signs, as the figure indicates.

3-2 Addition of Vectors – Graphical Methods
If the motion is in two dimensions, the situation is somewhat more complicated.
Here, the actual travel paths are at right angles to one another; we can find the displacement by using the Pythagorean Theorem.

\[ D_R = \sqrt{D_1^2 + D_2^2} \]
3-2 Addition of Vectors – Graphical Methods

Adding the vectors in the opposite order gives the same result:

\[ \vec{V}_1 + \vec{V}_2 = \vec{V}_2 + \vec{V}_1 \]

3-2 Addition of Vectors – Graphical Methods

Even if the vectors are not at right angles, they can be added graphically by using the “tail-to-tip” method.

3-3 Subtraction of Vectors, and Multiplication of a Vector by a Scalar

In order to subtract vectors, we define the negative of a vector, which has the same magnitude but points in the opposite direction.

Then we add the negative vector:

\[ \vec{V} - \vec{V}_1 = \vec{V} + (-\vec{V}_1) = \vec{V} - \vec{V}_1 \]

3-3 Subtraction of Vectors, and Multiplication of a Vector by a Scalar

A vector \( V \) can be multiplied by a scalar \( c \); the result is a vector \( cV \) that has the same direction but a magnitude \( cV \). If \( c \) is negative, the resultant vector points in the opposite direction.

\[ \vec{V}_2 = 1.5 \vec{V} \]

\[ \vec{V}_3 = -2.0 \vec{V} \]
3-4 Adding Vectors by Components

• Any vector can be expressed as the sum of its components.
• Components are perpendicular to each other.

If the components are perpendicular, they can be found using trigonometric functions.

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3-4 Adding Vectors by Components

Adding vectors:
1. Draw a diagram; add the vectors graphically.
2. Choose x and y axes.
3. Resolve each vector into x and y components.
4. Calculate each component using sines and cosines.
5. Add the components in each direction.
6. To find the length and direction of the vector, use:

\[ V = \sqrt{V_x^2 + V_y^2} \]
\[ \tan \theta = \frac{V_y}{V_x} \]