

② Vector addition

$\vec{u} = (a, b)$   
 $\vec{v} = (c, d)$   
 $\vec{u} + \vec{v} = (a+c, b+d)$

Geometric

E.g.  $\vec{u} = (3, -5)$   
 $\vec{v} = (-1, 7)$   
 $\vec{u} + \vec{v} = (2, 2)$

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$\vec{u} = (-1, 3); \vec{v} = (5, 2)$   
 $3\vec{u} + 7\vec{v} = (32, 23)$   
 $(-3, 9) + (35, 14)$   
 $\vec{u} - \vec{v} = \vec{u} + (-1)\vec{v}$   
 $= (-1, 3) + (-5, -2)$   
 $= (-6, 1)$

E.g.  $\vec{u} = (1, 5); \vec{v} = (-2, -3); \vec{w} = (4, -1)$

Find  $\vec{u} + \vec{v} - \vec{w}$  and  $4\vec{v} + 2\vec{u} - 2\vec{w}$ .

$\vec{u} + \vec{v} - \vec{w} = (-5, 3); 4\vec{v} + 2\vec{u} - 2\vec{w} = (-14, 0)$

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Unit Vectors

A unit vector is a vector of length 1

Find the unit vector in the direction of  $\vec{v}$ ?

$\vec{v} = (3, 4)$   
 $|\vec{v}| = \sqrt{3^2 + 4^2} = 5$

The unit vector in the direction of  $\vec{v} = (a, b)$  is the vector  $\frac{\vec{v}}{|\vec{v}|} = \left( \frac{a}{\sqrt{a^2 + b^2}}, \frac{b}{\sqrt{a^2 + b^2}} \right)$

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Ex: Find the unit vector in the direction of the vector  $\vec{v} = (-5, 12)$

Ans:  $\frac{\vec{v}}{|\vec{v}|} = \left( \frac{-5}{\sqrt{(-5)^2 + (12)^2}}, \frac{12}{\sqrt{(-5)^2 + (12)^2}} \right)$   
 $= \left( \frac{-5}{13}, \frac{12}{13} \right)$

Special Notations with vectors

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$\vec{i} = (1, 0)$ : unit vector in positive x-direction  
 $\vec{j} = (0, 1)$ : unit vector in positive y-direction

$\vec{u} = (8, 5) = 8\vec{i} + 5\vec{j}$

In general,  $\vec{v} = (a, b)$ , we can always rewrite  $\vec{v}$  as  $\vec{v} = a\vec{i} + b\vec{j}$

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E.g.  $\vec{u} = 3\vec{i} - 4\vec{j}$   
 $\vec{v} = -5\vec{i} + 2\vec{j}$   
 $\vec{u} + \vec{v} = -2\vec{i} - 2\vec{j}$

In general, if  $\vec{u} = a\vec{i} + b\vec{j}; \vec{v} = c\vec{i} + d\vec{j}$   
 $\vec{u} + \vec{v} = (a+c)\vec{i} + (b+d)\vec{j}$   
 $\vec{u} - \vec{v} = (a-c)\vec{i} + (b-d)\vec{j}$

Component form of a vector

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