Chapter 3:Kinematics in Two Dimensions: Vectors

Lecture 3

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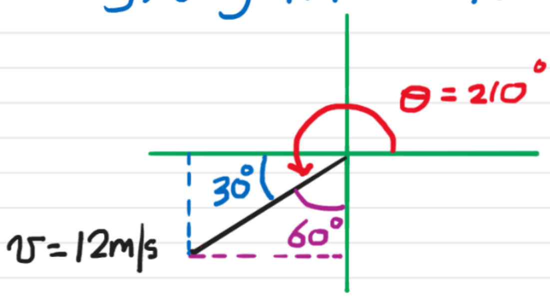
Example: Find the x- and y-components of the velocity, using three different alternatives.

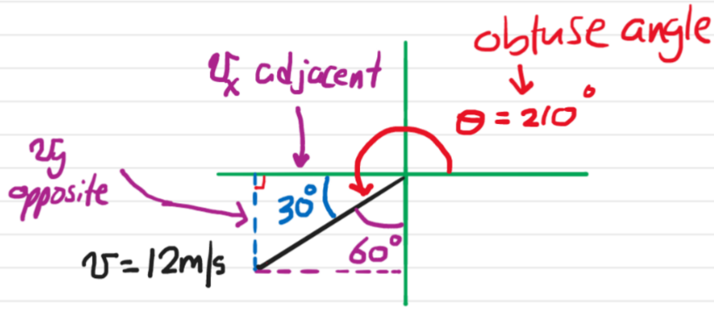


① Use the angle $\theta = 210^\circ$ measured with respect to the positive x-axis in a counterclockwise direction.

$v_x = 12 \cos 210^\circ = 12\left(-\frac{\sqrt{3}}{2}\right) = -6\sqrt{3}$ m/s

$v_y = 12 \sin 210^\circ = 12\left(-\frac{1}{2}\right) = -6 \ m/s$

② use 30° acute angle



because in third quadrant

$v_x = -12 \cos 30^\circ$

$= -12\left(\frac{\sqrt{3}}{2}\right) = -6\sqrt{3} \ m/s$

$v_y = -12 \sin 30^\circ = -12\left(\frac{1}{2}\right) = -6 \ m/s$

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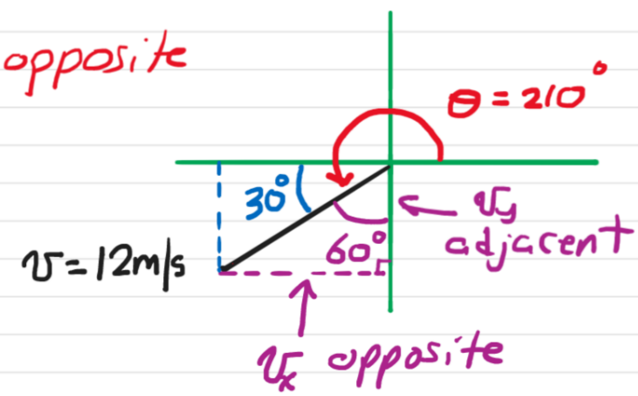
since v lies in third quadrant

because v_x is opposite to 60° angle

$v_x = -12 \sin 60^\circ$

$= -12\left(\frac{\sqrt{3}}{2}\right) = -6\sqrt{3} \ m/s$



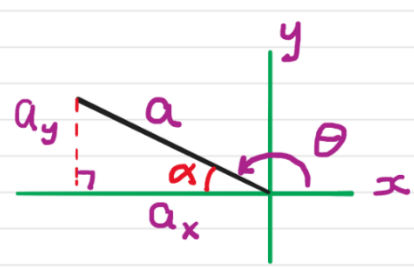
$v_y = -12 \cos 60^\circ = -12\left(\frac{1}{2}\right)$

$= -6 \ m/s$

v_y adjacent to 60° angle

Example Find a and θ.

$a_x = -7\sqrt{3} \ m/s^2$, $a_y = 7 \ m/s^2$



$a = \sqrt{a_x^2 + a_y^2} = \sqrt{(-7\sqrt{3})^2 + (7)^2}$

$a = \sqrt{3 \times 49 + 49} = \sqrt{49(3+1)}$

$a = 7\sqrt{4} = 14 \ m/s^2$

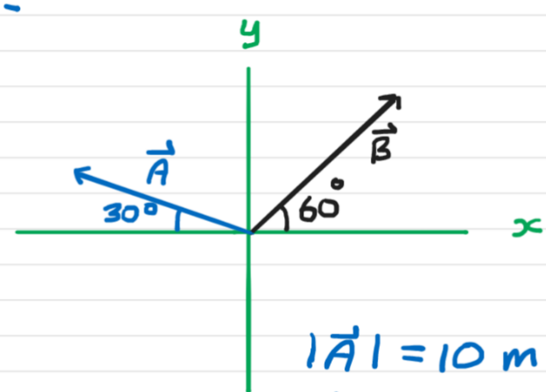
$\tan\alpha = \left|\frac{\text{opposite side}}{\text{adjacent side}}\right| = \left|\frac{7}{-7\sqrt{3}}\right| = \frac{1}{\sqrt{3}}$ absolute magnitude since α is an acute angle

$\Rightarrow \alpha = 30^\circ$

$\theta = 180^\circ - 30^\circ = 150^\circ$.

Adding Vectors by Components.

Find $\vec{R} = \vec{A} + \vec{B}$
by using the components method.



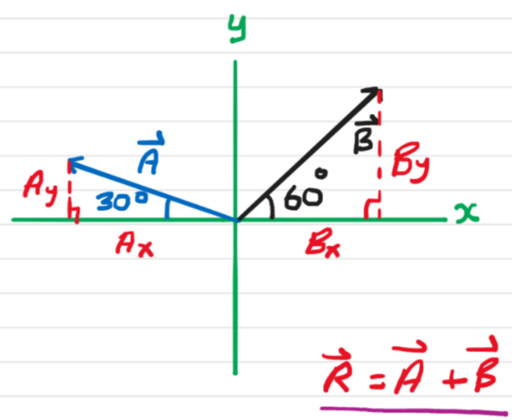
Resolve each vector into its x- and y-components.

$A_x = -10\cos 30^\circ = -10\left(\frac{\sqrt{3}}{2}\right) = -5\sqrt{3}$ m

$A_y = 10\sin 30^\circ = 10\left(\frac{1}{2}\right) = 5$ m

$B_x = 30\cos 60^\circ = 30\left(\frac{1}{2}\right) = 15$ m

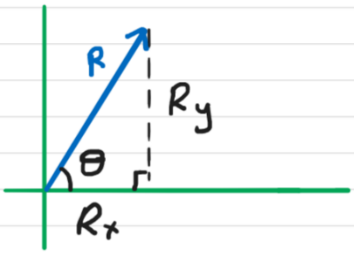
$B_y = 30\sin 60^\circ = 30\left(\frac{\sqrt{3}}{2}\right) = 15\sqrt{3}$ m



Find the components of the resultant:

$R_x = A_x + B_x = -5\sqrt{3} + 15 = 6.3$ m

$R_y = A_y + B_y = 5 + 15\sqrt{3} = 30.9$



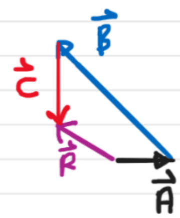
magnitude of resultant

$R = \sqrt{R_x^2 + R_y^2} = 31.5$ m .

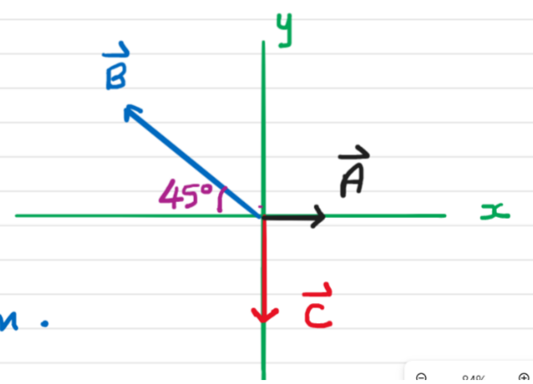
$\tan\theta = \left|\frac{R_y}{R_x}\right| \Rightarrow \theta \sim \underline{78.5^\circ}$.

θ gives the direction of the resultant.

Example: Find the resultant vector $\vec{R} = \vec{A} + \vec{B} + \vec{C}$ using the components method.



$|\vec{A}| = 4m, \ |\vec{B}| = 12m, \ |\vec{C}| = 6m$



$A_x = 4\cos 0 = 4m$

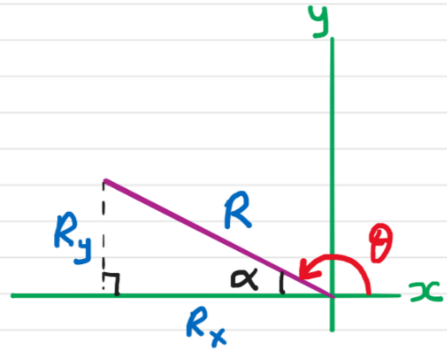
$A_y = 4\sin 0 = 0$

$B_x = -12\cos 45^\circ = -12\left(\frac{1}{\sqrt{2}}\right) = -\frac{12}{\sqrt{2}}$ m .

$B_y = 12 \sin 45^\circ = 12\left(\frac{1}{\sqrt{2}}\right) = \frac{12}{\sqrt{2}}$ m.

$C_x = 6 \cos(270^\circ) = 0$

$C_y = 6 \sin 270^\circ = 6(-1) = -6$ m.



$R_x = A_x + B_x + C_x = -4.5$

$R_y = A_y + B_y + C_y = 2.5$

$R = \sqrt{R_x^2 + R_y^2} \approx 5.1$ m

$R = \sqrt{R_x^2 + R_y^2} \approx 5.1$ m

$\tan\alpha = \left|\frac{\text{opposite}}{\text{adjacent}}\right| = \left|\frac{2.5}{-4.5}\right| \Rightarrow 29^\circ$

$\therefore \theta = 180^\circ - 29^\circ = 151^\circ$