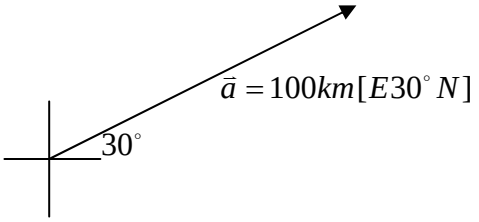
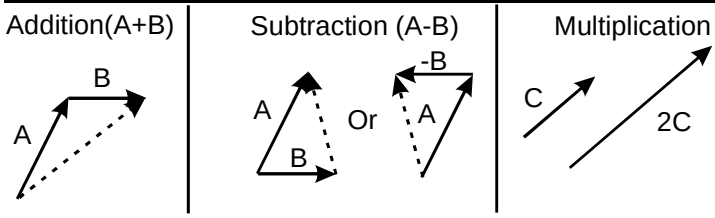
Vectors

Notation: Although there are many accepted standards for vector notation, the preferred method is exemplified below.



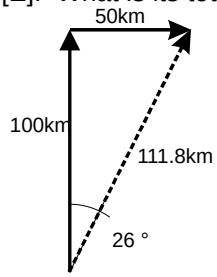
With this notation, the direction is read as follows. Facing the East, rotate 30^0 to the North. The alternative notation is $\vec{a} = 100\,km[30^\circ N\ of\ E]$. This notation is acceptable but $\vec{a} = 100km[E30^\circ N]$ is preferred.

Addition, Subtraction and Multiplication of Vectors



One of the most elegant aspects of physics is the way in which it can demonstrate to students the practical applications of many mathematical concepts. By the time most people are introduced to physics, they have been introduced to much of the math required to solve the problems. For example, solving any of the 2D motion problems requires the use of **Trig, Pythagorean Theorem** or **graphical techniques.**

Example.
A plane flies 100km[N] then turns and flies 50km[E]. What is its total displacement?



This question could be done a couple of ways.

Method 1: draw the diagram to scale (adding the vectors head to tale) with a ruler and a protractor and measure the **resultant**.

$$\vec{r} = 111.8km[N26^\circ E]$$

Method 2: Using the **Pythagorean Theorem, Cosine Law** or **Sine Law** to find the length of the resultant. In this case we can simply use **Pythagorean Theorem.**

$$h^2 = a^2 + b^2$$
$$h^2 = (100)^2 + (50)^2$$
$$h^2 = 12500$$
$$h = 111.8km$$

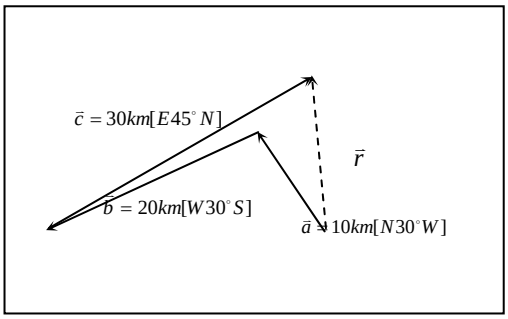
Then using a convenient trig ratio to find the angle

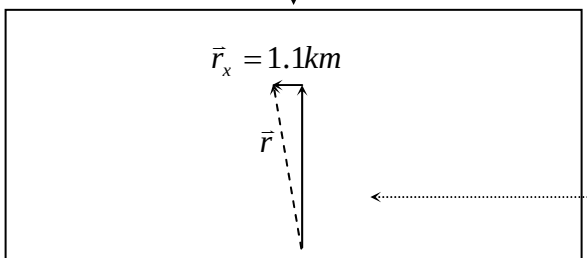
$$\tan\theta = \frac{50}{100}$$
$$\theta = 26^\circ$$
$$\therefore \vec{r} = 111.8km[N26^\circ E]$$

Method 3: Resolving in components. This method is used when working with questions with two or more vectors. Since in this question the vectors are already put into components, this method is not used.

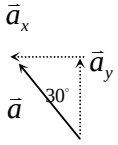
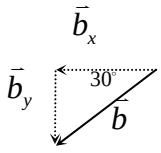
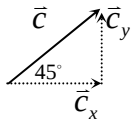
The following example uses components.

Ex: Add the flowing vectors together $\vec{a} = 10km[N30^\circ W]$, $\vec{b} = 20km[W30^\circ S]$, $\vec{c} = 30km[E45^\circ N]$





Exercise: Find $\vec{r}$

Vector	X-Comp	Y-Comp
	$\sin 30^\circ = \frac{\vec{a}_x}{\vec{a}}$ $\vec{a}_x = \vec{a}\sin 30^\circ$ $\vec{a}_x = 10km\sin 30^\circ$ $\vec{a}_x = 5.0km[W]$	$\cos 30^\circ = \frac{a_y}{a}$ $a_y = a\cos 30^\circ$ $\vec{a}_y = 10km\cos 30^\circ$ $\vec{a}_y = 8.7km[N]$
	$\cos 30^\circ = \frac{\vec{b}_x}{\vec{b}}$ $\vec{b}_x = \vec{b}\cos 30^\circ$ $\vec{b}_x = 20km\cos 30^\circ$ $\vec{b}_x = 17.3km[W]$	$\sin 30^\circ = \frac{\vec{b}_y}{\vec{b}}$ $\vec{b}_y = \vec{b}\sin 30^\circ$ $\vec{b}_y = 20km\sin 30^\circ$ $\vec{b}_y = 10km[S]$
	$\cos 45^\circ = \frac{\vec{c}_x}{\vec{c}}$ $\vec{c}_x = \vec{c}\cos 45^\circ$ $\vec{c}_x = 30km\cos 45^\circ$ $\vec{c}_x = 21.2km[E]$	$\sin 45^\circ = \frac{\vec{c}_y}{\vec{c}}$ $\vec{c}_y = \vec{c}\sin 45^\circ$ $\vec{c}_y = 30km\sin 45^\circ$ $\vec{c}_y = 21.2km[N]$
	$\vec{r}_x = \vec{a}_x + \vec{b}_x + \vec{c}_x$ $= -5.0km - 17.3km + 21.2km$ $= -1.1km$	$\vec{r}_y = \vec{a}_y + \vec{b}_y + \vec{c}_y$ $= 8.7km - 10km + 21.2km$ $= 19.9km$