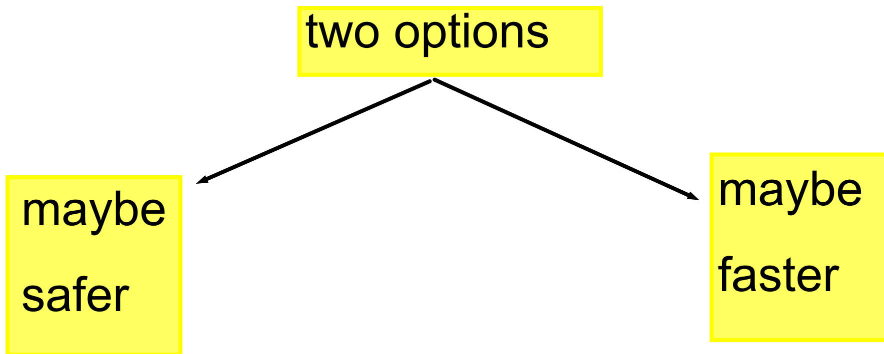
Vector Subtraction: Graphical Methods



Head - to - Tail

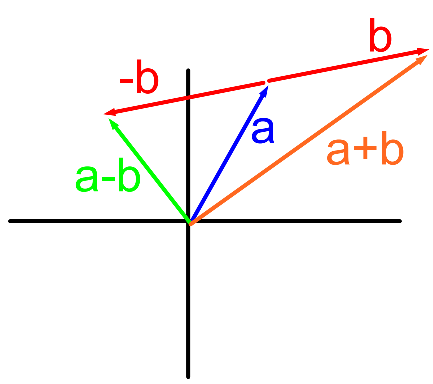
- rewrite subtraction as addition

$\Delta\vec{V} = \vec{V_2} - \vec{V_1}$ $\Delta d = d_2 - d_1$

$= \vec{V_2} + (-\vec{V_1})$ $= d_2 + (-d_1)$

rotate 180°

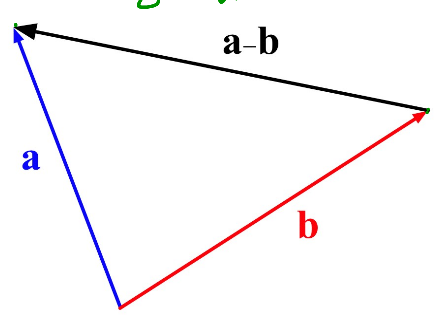
- use head-to-tail method
- measure the magnitude and direction of the "change in" vector



Tail - to -Tail with flip

- draw the vectors tail-to-tail (tails on the origin of the compass)
- Resultant vector (the "change in" vector) is drawn with tail starting at second vector and the head going to the head of the first vector
- A-B points from head of B to head of A
- measure the magnitude and direction of the "change in" vector.

$\Delta\vec{V} = \vec{V_f} - \vec{V_i}$



NOTE : Order of subtraction does matter.

ex. C = A - B and D = B - A

such that C ≠ D

Vector Subtraction: Graphical Methods

Safe method- rewrite as an addition

A planes velocity changes from 200 km/h [N] to 300 km/h [N 30° W].

a) What is the change in velocity of the plane?
b) What was the acceleration of the plane if it took 45 s to change direction?

Scale: 1.0 cm = 25 km/h

$\vec{V}_1 = 200$ km/h [N] $\longrightarrow -\vec{V}_1 = \underline{200\text{ km/h [S]}}$

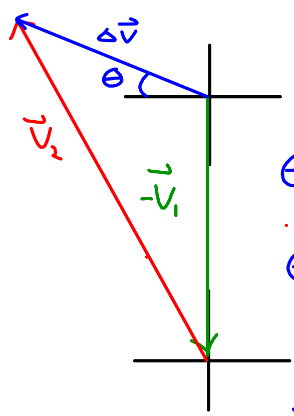
$\vec{V}_2 = \underline{300\text{ km/h [N 30° W]}}$

$\Delta t = 45$ s

$\Delta\vec{v} = \vec{V}_2 - \vec{V}_1 = \vec{V}_2 + (-\vec{V}_1)$

$200\text{ km/h} \times \frac{1.0\text{ cm}}{25\text{ km/h}} = 8.0\text{ cm}$

$300\text{ km/h} \times \frac{1.0\text{ cm}}{25\text{ km/h}} = 12.0\text{ cm}$



$\Delta\vec{v} = 6.4$ cm

$6.4\text{ cm} \times \frac{25\text{ km/h}}{1.0\text{ cm}} = 160\text{ km/h}$

$\theta = 21°$

$\Delta\vec{v} = 160$ km/h [W 21° N]

b) $\vec{a} = \frac{\Delta\vec{v}}{\Delta t} = \frac{44.44\text{ m/s}}{45\text{ s}} = \boxed{0\ 99\text{ m/s}^2\text{ [W 21° N]}}$

$160\text{ km/h} \times \frac{1000\text{ m}}{1\text{ km}} \times \frac{1\text{ h}}{3600\text{ s}} = 44\ 4\text{ m/s}$

Vector Subtraction: Graphical Methods

Fast method- start both at origin

Dan is moving at 4.8 m/s [E] initially. He changes his velocity to 3.6 m/s [N] in 2.88 s.

a) What is the change in his velocity?

b) What is his acceleration?

Scale: 1.0 cm = 0.6 m/s

$\vec{V}_1 = 4.8 \, m/s \, [E]$ $\qquad 4.8 \, m/s \times \frac{1.0 \, cm}{0.6 \, m/s} = 8.0 \, cm$

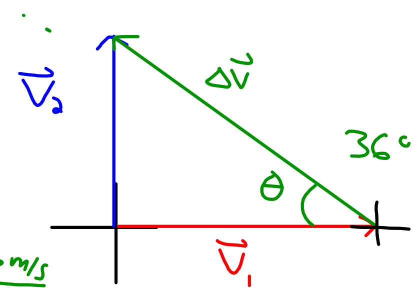
$\vec{V}_2 = 3.6 \, m/s \, [N]$ $\qquad 3.6 \, m/s \times \frac{1.0 \, cm}{0.6 \, m/s} = 6.0 \, cm$

$\Delta t = 2.88 \, s$

$\Delta \vec{v} = \vec{V}_2 - \vec{V}_1$

$\Delta \vec{v} = \vec{V}_2 - \vec{V}_1$

$\Delta \vec{V} = 10.0 \, cm$



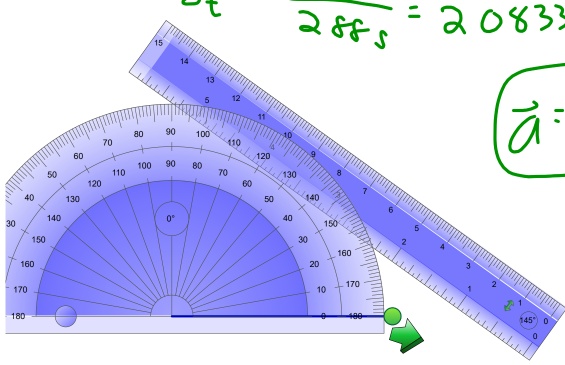
$10.0 \, cm \times \frac{0.6 \, m/s}{1.0 \, cm}$

$= 6.0 \, m/s$

$\Delta \vec{V} = 6.0 \, m/s \, [W \, 36° \, N]$

b) $= \vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{6.0 \, m/s}{2.88 \, s} = 2.08333 \, m/s^2$

$\boxed{\vec{a} = 2.1 \, m/s^2 \, [W \, 36° \, N]}$



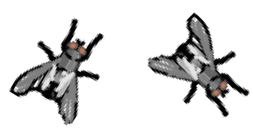
More Subtraction:

1. When you answer your cell, you are 45 m [NE] of the main entrance. When you finish the call you are 65 m [W 20 ^{o} N] of the main entrance. Your call lasted 3.0 minutes.

   a) What was your displacement during this call?

   b) What was your average velocity, in m/s, during the call?

2. A housefly is moving 2.8 m/s [N 25 ^{o} up] when you attempt to swat it. You miss and the fly moves away at 3.4 m/s [N 50 ^{o} down]. If the fly was able to change its velocity in 125 ms, what was it average acceleration, in m/s^2?



1a) 93 m [W 6^0 S]

1b) 0.52 m/s [W 6^0 S]

2) 3.8 m/s [-96^0]

30 m/s^2 [-96^0]