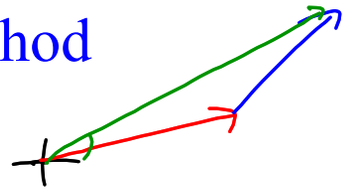
# Vector Addition - Graphical Method



- Vectors are added "head-to-tail" (tip to tail)

The first vector (A) is drawn with the tail on the origin.

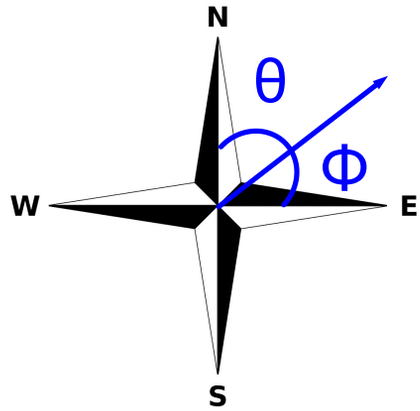
Put the tail of the second vector at the head of the first vector.

Draw the resultant vector from the origin to the head of the second vector.

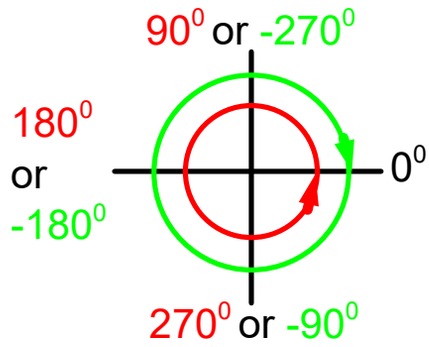
Measure the length of the resultant and note direction.

- These basic rules apply for vectors in any directions

- How to represent the direction?
  - > Compass - N, E, W, S
  - > If direction between major axes then write in format where the angle ($<90^0$) indicates a rotation from the Starting Axes towards the Ending Axes
    E.g. [N θ E] or [E Φ N]




  - > Angle - $0^0$ is always considered to be to the right
    - – Count Clockwise (CCW)
      Angle range $0^0$ -> $360^0$
    - – Clockwise (CW)
      Angle range $0^0$ -> $-360^0$



# In One Dimension (1D)

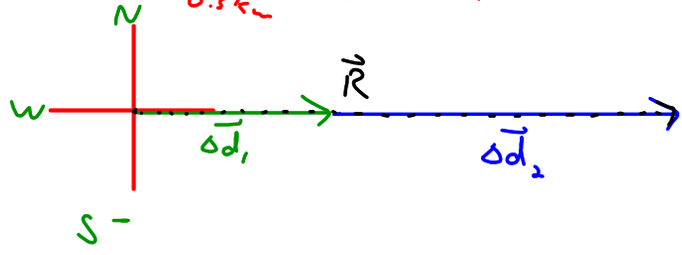
- Vectors are either Parallel (same direction) or Anti-Parallel (opposite direction) 180°
- This means the resultant vector will either the same or opposite direction as all the individual vectors involved
- This is really easy mathematically. When a vector direction is opposite another vector, you can change to direction by $180^0$ and then the magnitude becomes negative
  > 15 m [E] = -15 m [W] 9 N [$45^0$] = -9 N [$225^0$]

a) Draw the vector addition to find the resultant displacement given $\Delta d_1$ = 1.8 km [E] and $\Delta d_2$ = 3.2 km [E]. scale let 1.0 cm = 0.5 km

answer [compass] = 5.05 Km [E]
answer [ CCW] = 5.05 Km [0°]
answer [ CW] = 5.05 Km [0°]

$\Delta d_1 = 1.8\ km \times \frac{1.0\ cm}{0.5\ km} = 3.6\ cm$

$\Delta d_2 = 3.2\ km \times \frac{1.0\ cm}{0.5\ km} = 6.4\ cm$




$R = 10.1\ cm \times \frac{0.5\ km}{1.0\ cm} = 5.05\ km$

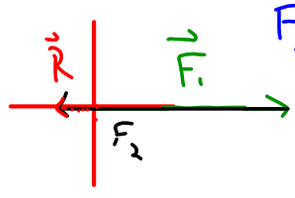
b) Draw the vector addition to find the resultant horizontal force acting on the object given the applied force is 3.6 N [E] and the force of kinetic friction is 4.3 N [W].

answer [compass] = 0.7 N [W]
answer [ CCW] = 0.7 N [180°]
answer [ CW] = 0.7 N [-180°]

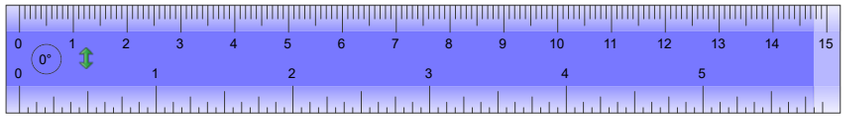
Scale 1.0 cm = 1.0 N

$F_1 = 3.6N \times \frac{1.0\ cm}{1.0\ N} = 3.6\ cm$

$F_2 = 4.3N \times \frac{1.0\ cm}{1.0\ N} = 4.3\ cm$

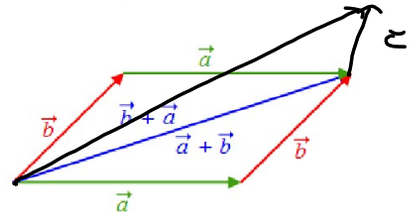



$\vec{R} = 0.7\ cm \times \frac{1.0N}{10\ cm} = 0.7N$



# Adding Vectors In Two Dimensions (2D) Graphically

- Things to remember: Head-to-Tail, Givens, Scale, Drawing values, Equation, Arrowheads, Labels, Raw and Rounded answers
- Adding is Commutative
  - > Order does not matter
  - > Drawing both creates a parallelogram
- Works for any number of vectors

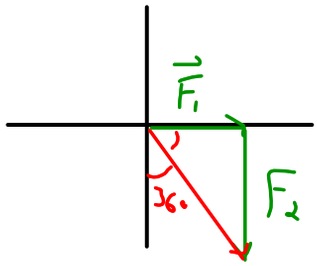



Ex 1: Find the net applied force if person one exerts 2.5 N east and person two applies 3.5 N south?

1.0 cm = 1.0 N

$F_1 = 2.5N \times \frac{1.0cm}{1.0N} = 2.5cm$

$F_2 = 3.5N \times \frac{1.0cm}{1.0N} = 3.5cm$



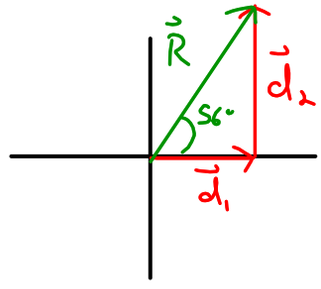

$R = 4.3cm \times \frac{1.0N}{1.0cm} = 4.3N$

$\vec{R} = 4.3N\ [S\ 36°\ E]$

Ex 2: Find the displacement of an airplane that flies 50 km due east and then 77 km due north. 1.0 cm = 20 km

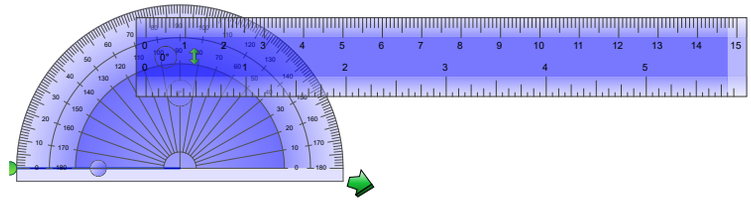
$d_1 = 50km \times \frac{1.0cm}{20km} = 2.5\ cm$

$d_2 = 77km \times \frac{1.0cm}{20km} = 3.85\ cm \approx 3.9\ cm$




$R = 4.7cm \times \frac{20\ km}{1.0\ cm} = 94\ km$

$\vec{R} = 94\ km\ [E\ 56°\ N]$



# Adding Vectors In Two Dimensions (2D) Graphically

- Method works for any number of vectors in any order

Ex 3: Alice and Bob start walking from the same point. Alice walks 5.0 m [NE], then 3.0 m [SE], then 4.0 m [N]. Bob walks 3.0 m [SE], then 4.0 m [N], then 5.0 m [NE]. Show that they end at the same spot. What is their resultant displacement? 1.0 cm = 1 m [NE] = [N 45° E] [E 45° N]