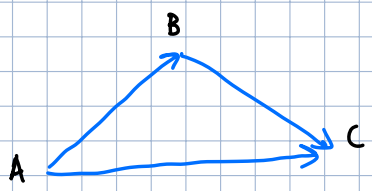
Relative Motion Notation

$AB + BC = AC$



The relative motion problems will be vector additions and subtractions as

$$CD - BA + BC - ED$$
$$= CD + (-BA) + BC + (-ED)$$
$$= CD + AB + BC + DE$$
$$= AC + BC + CD + DE$$
$$= AC + CE$$
$$= AE$$

Relative Motion Terminology

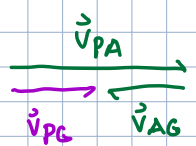
The velocity of plane relative to the air : $\vec{V}_{PA}$

The velocity of the air with respect to the ground : $\vec{V}_{AG}$

The velocity of the plane respect to the ground : $\vec{V}_{PG}$

Example 1:

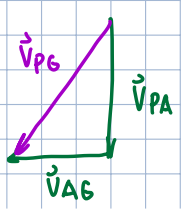
A plane flies east, the wind is west. What is its velocity with respect to the ground?
A A



$$\vec{V}_{PA} + \vec{V}_{AG} = \vec{V}_{PG}$$

Example 2:

A plane flies south, the wind is west. What is its velocity with respect to the ground?

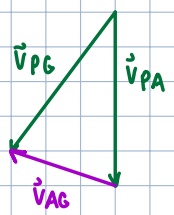


$$\vec{V}_{PA} + \vec{V}_{AG} = \vec{V}_{PG}$$

Example 3:

A plane heads south, but ends up going southwest. What is the velocity of the wind?

This time you know your destination, therefore vector subtraction



(always point towards goal)

$\vec{V}_{PG} - \vec{V}_{PA}$

$= \vec{V}_{PG} + \vec{V}_{AP}$

$= \vec{V}_{AP} + \vec{V}_{PG}$

$= \vec{V}_{AG}$

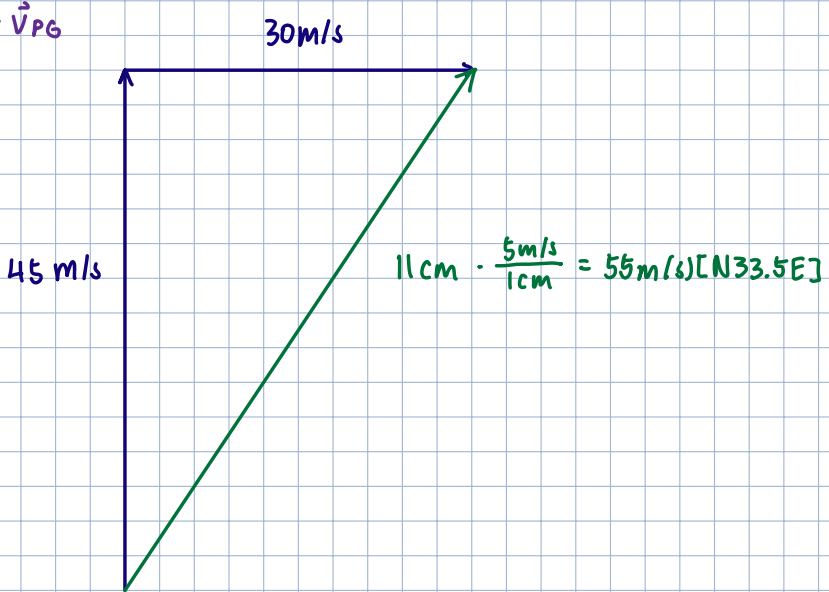
Relative Motion

1) Jeb flies 45m/s [N] with a wind blowing at 30m/s [E]. What is Jeb's velocity with respect to the ground?

$\vec{V}_{PA}$ $\vec{V}_{PG}$ $\vec{V}_{AG}$

1cm = 5m/s

$\vec{V}_{PA} + \vec{V}_{AG} = \vec{V}_{PG}$

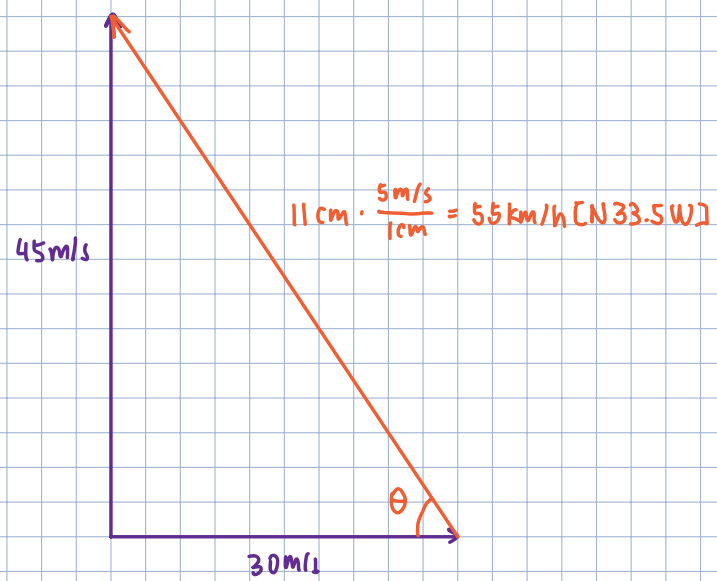


$11\,cm \cdot \frac{5\,m/s}{1\,cm} = 55\,m/s\,[N33.5E]$

$\vec{v}_{PG}$ $\vec{v}_{AG}$

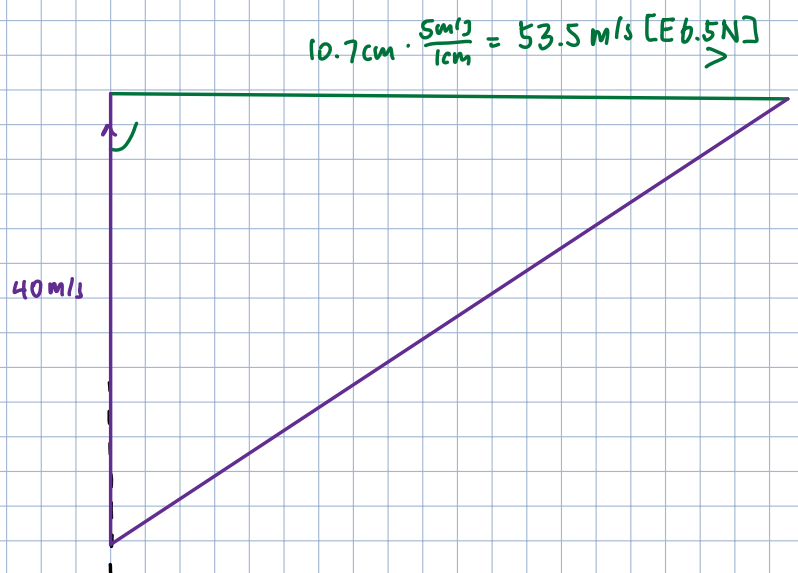
Jeb wants to fly 45m/s [N] but the wind is blowing 30m/s[E]. What must he do?

1cm = 5m/s



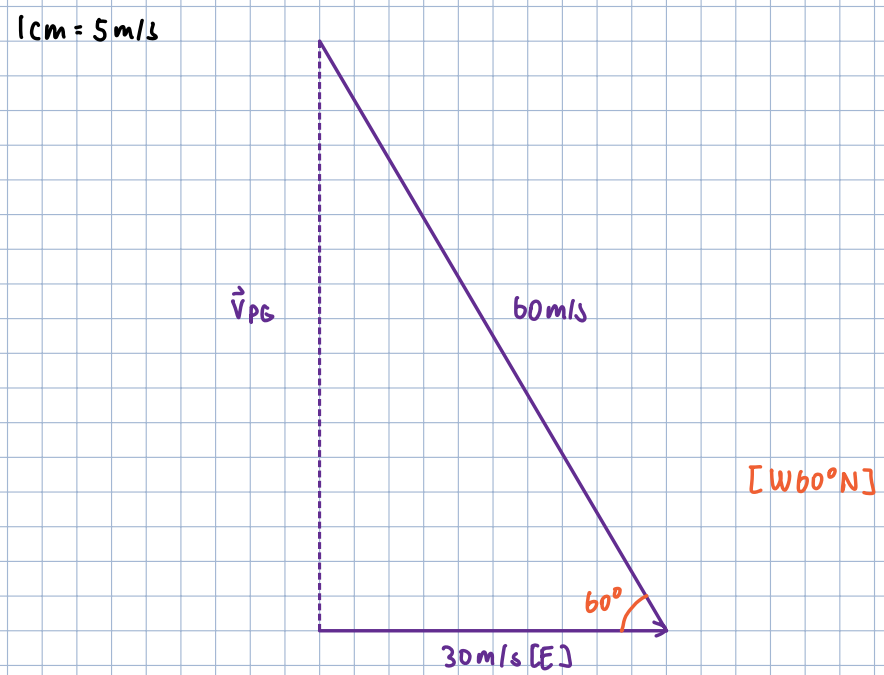
3) In order to fly 20m/s[N60E], Jeb flies 40m/s[N]. What is the wind speed?

1cm = 5m/s



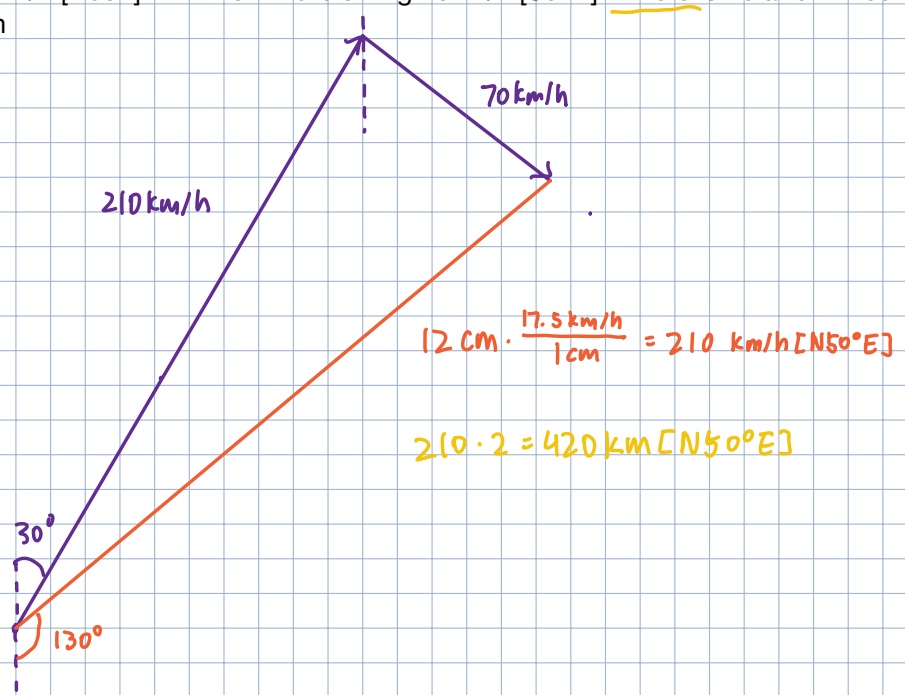
V_{PG} V_{AG} V_{PA}

Jeb wants to fly north, but the wind blows 30m/s[E]. If he wants to fly at 60m/s, what must his heading be?



$\vec{V}_{PA}$ $\vec{V}_{AG}$

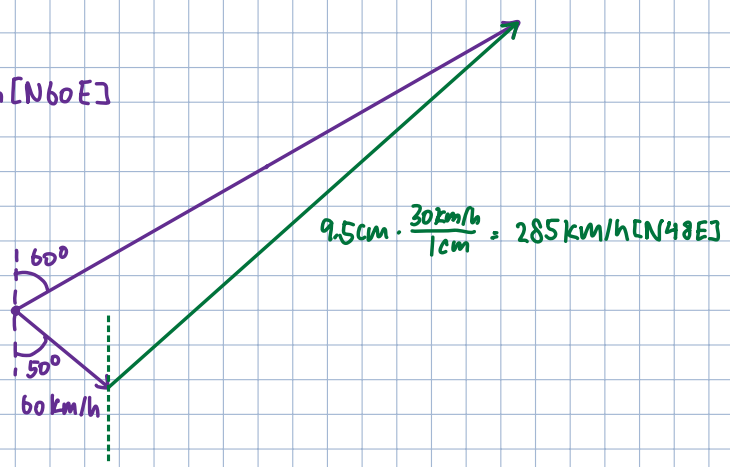
Jeb flies at 210km/h [N30E] with the wind blowing 70km/h [S52E]. Where is he after 2 hours?
1cm = 17.5km/h



Montreal is 600km [N60E] of Toronto. If the wind is blowing 60km/h [S50E] and Jeb wants to fly there in 2 hours, what must he do?

1cm = 30 km/h

$\vec{v} = \frac{\vec{d}}{t} = \frac{600}{2} = 300\ km/h\ [N60E]$



Water:

Current (wind): Vag

still water relative to water: Vpa

with relative to shore (ground): Vpg

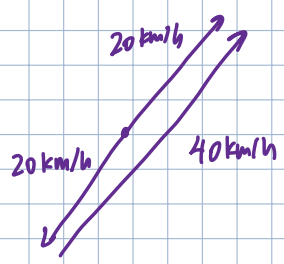
Two objects in motion: Example

Train A travels 20km/h NE, while train B travels 20km/h SW, both with relative to the ground

a) What is the velocity of train A relative to train B?

$\vec{V}_{AB} = \vec{V}_{AG} + \vec{V}_{GB}$

$\vec{V}_{AB} = \vec{V}_{AG} - \vec{V}_{BG}$



b) What is the velocity of train B relative to Train A?

40km/h [SW]