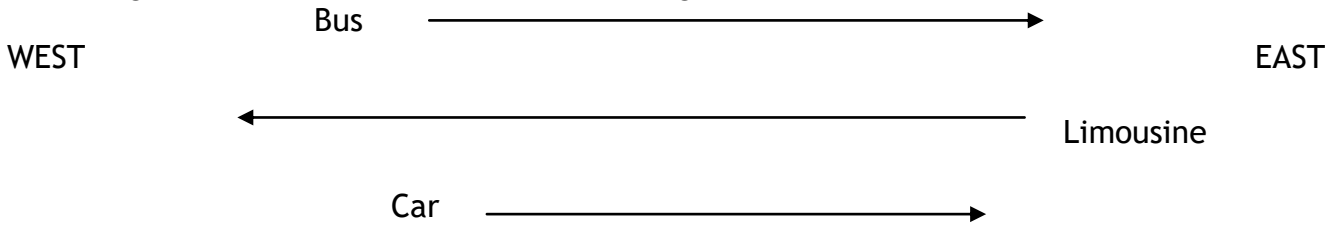


Relative Velocity

Consider the situation indicated in the diagram involving a car travelling at 90 km/h, a bus travelling at 95 km/h and a limousine travelling at 125 km/h.

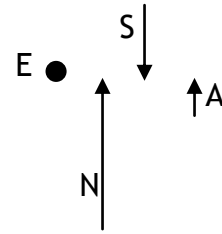


- Find the velocity of the limousine relative to the car.
- Find the velocity of the car relative to the limousine.
- Find the velocity of the car relative to the bus.
- Find the velocity of the bus relative to the car.
- Find the velocity of the limousine relative to the bus.
- Find the velocity of the bus relative to the limousine.

Relative Velocity: The velocity of one object with respect to (w.r.t) another object (as if it were at rest)

Consider:

- Emmerson is standing(still) on the sidewalk
- Nick is driving on the street at 60km/h [N]
- Serena is biking on the street 20 km/h [S]
- Andrew is running along the street at 10 km/h [N]



Emmerson sees Nick going 60 km/h [N] but Nick sees Emmerson moving south at 60km/h
Relative velocity

Andrew sees Nick driving at 50 km/h [N]

Nick sees Andrew running at 50 km/h [S]

$$\begin{aligned}
 \vec{v}_{\text{Nick relative to Andrew}} &= \vec{v}_{\text{Nick}} - \vec{v}_{\text{Andrew}} \\
 &= 60 - (+10) \\
 &= 50 = 50 \text{ km/h [N]}
 \end{aligned}$$

Serena sees Nick driving at 80 km/h [N]

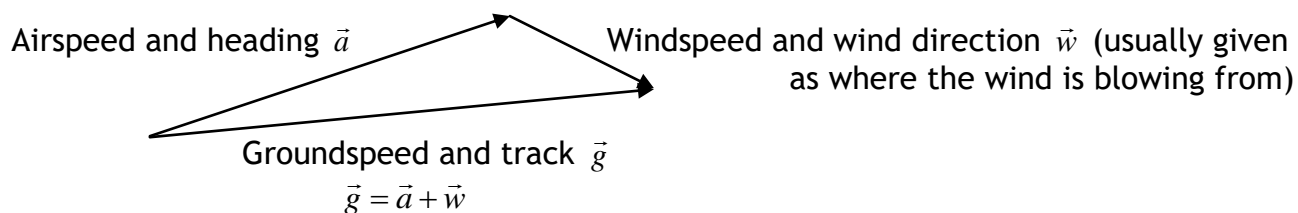
Nick sees Serena biking at 80 km/h [S]

$$\begin{aligned}
 \vec{v}_{\text{Serena relative to Nick}} &= \vec{v}_{\text{Serena}} - \vec{v}_{\text{Nick}} \\
 &= -20 - (+60) \\
 &= -80 = 80 \text{ km/h [S]}
 \end{aligned}$$

In general: Velocity of A relative to B = $\vec{v}_A - \vec{v}_B$

Ex. A ship is travelling at 15 knots in the direction $S40^\circ W$. A submarine 8 nautical miles due west of the ship is travelling at 9 knots at $S55^\circ E$. Find the velocity of the ship relative to the submarine? Does the ship pass in front of or behind the submarine?

Airplane situation

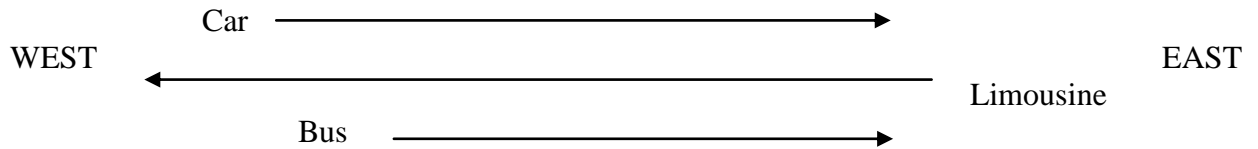


In these questions you will be given two of the vectors and asked to find the third.

Ex. A pilot steers her plane at $N30^\circ E$ with an airspeed of 545 km/h. If the wind is 85 km/h from $S20^\circ E$, what is the track and groundspeed of the plane?

Vector Operations

1. Consider the situation indicated in the diagram involving a car travelling at 110 km/h, a bus travelling at 95 km/h and a limousine travelling at 125 km/h.



- a) Find the velocity of the limousine relative to the bus. {220 km/h West}
- b) Find the velocity of the car relative to the bus. {15 km/h East}
2. A pilot sets her plane at a heading of $N24^\circ W$ with a airspeed of 625 km/h. The pilot is blown off course by a wind from $N84^\circ E$ at 80 km/h, determine the groundspeed and the track of the plane?
{654.12 km/h at $N30.58^\circ W$ }
3. A pilot heads her plane at NW with an airspeed of 500 km/h. If the actual groundspeed of the plane is 480 km/h at a track of $N35^\circ W$ determine the windspeed and the wind direction.
{87.7 km/h from $S63.1^\circ W$ }
4. An ocean cruiser is travelling at 20 knots in the direction $S80^\circ W$. A sailing boat 8 nautical miles due west of the ocean cruiser is travelling at 7 knots at $S40^\circ E$. Find the velocity of the ocean cruiser relative to the sailboat? Does the ocean liner pass in front of or behind the sailboat?
{24.3 knots at $W4.4^\circ N$, OC passes behind SB}