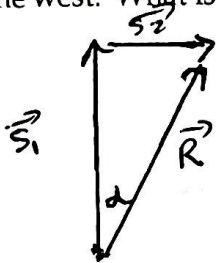# Day 2: 7.2 Velocity

Velocity is a vector quantity, as the direction of motion as well as magnitude is important. **Speed** is the **magnitude of velocity**.

In velocity applications, the resultant (ground speed) is the speed of a plane or boat relative to a person on the ground which includes the effect of wind or current on the air/water speed.

A key step to solving a problem is to find an angle in the triangle formed by the vectors whose directions are given. It is helpful to draw small axes at the tail or head of the vectors when drawing diagrams.

Ex 1: A plane travels due north at an airspeed of 900 km/h. It encounters a wind blowing at 80 km/h from the west. What is the resultant velocity of the plane?

$$|\vec{R}|^2 = |\vec{s_1}|^2 + |\vec{s_2}|^2$$

$$|\vec{R}|^2 = 900^2 + 80^2$$

$$|\vec{R}| \doteq 903.54 \text{ km/hr} \quad N\ 5.1°E$$

$$\tan \alpha = \frac{80}{900}$$

$$\alpha \doteq 5.1°$$

Ex 2: A man can swim 3.5 km/h in still water. Find at what angle to the bank he must head if he wishes to swim directly across a river flowing at a speed of 2 km/h.
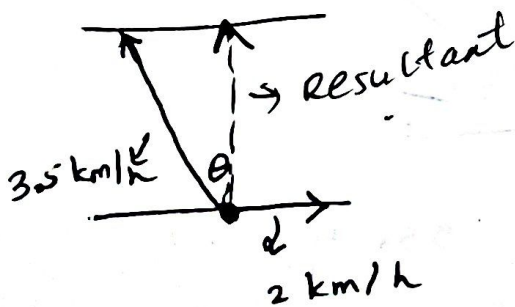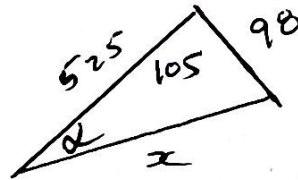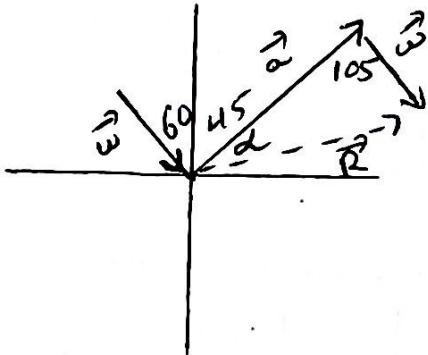
$$\sin \theta = \frac{2}{3.5}$$

$$\theta = 35°$$

∴ The man must swim at an angle of 35°.

Ex 3: A plane is steering $N\,45°E$ at an air speed of 525 km/h. The wind is from $N\,60°W$ at 98 km/h. Find the ground speed and course of the plane.

[solve by both geometry and component methods]

$$|\vec{R}| = x$$

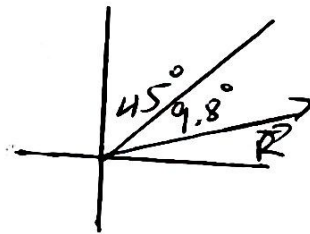$$x^2 = 525^2 + 98^2 - 2(525)(98)\cos 105$$

$$x^2 = 311861.48$$

$$x = 558.4 \text{ km/h}$$

$$\frac{\sin \alpha}{98} = \frac{\sin 105°}{558.4}$$
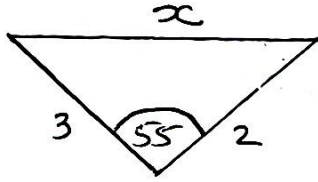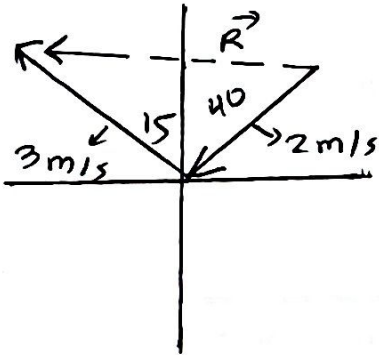
$$\sin \alpha = \frac{(98)(\sin 105)}{558.4}$$

$$\alpha = 9.8°$$

∴ Ground speed is 558.4 km/h and course of the plane is $N\,54.8°E$

Ex 4: A boat heads 15° west of north with a water speed of 3 m/s. Determine its velocity relative to the ground when there is a 2 m/s current from 40° east of north.

Let the magnitude be x

$$x^2 = 2^2 + 3^2 - 2(2)(3)\cos 55$$

$$x \doteq 2.5 \text{ km/h.}$$