Activity 7 Velocity vectors

Aim: Solve problems involving velocity vectors.

In the previous activity, you constructed scale diagrams of displacement vectors drawn "head to tail". We can extend this idea to any vector quantity to determine the resultant of two or more vectors.

Problem 1

A small power boat has a still-water speed of 6 m/s. The boat is to be driven across a river 150 m wide. There is a 2 m/s current flowing downstream, parallel to the banks of the river.

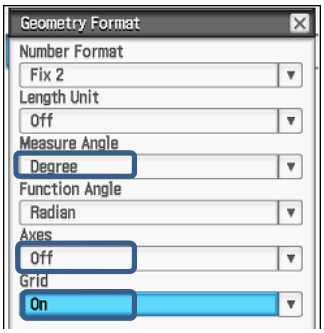
a) If the boat is pointed directly towards the opposite bank and travels at maximum speed, determine the resultant velocity.

b) To travel directly across the river at maximum speed,
   (i) on what angle should the bow of the boat be directed?
   (ii) how long will the boat take to cross the river?

The direction of the river is unknown. We will assume a west-east flow.

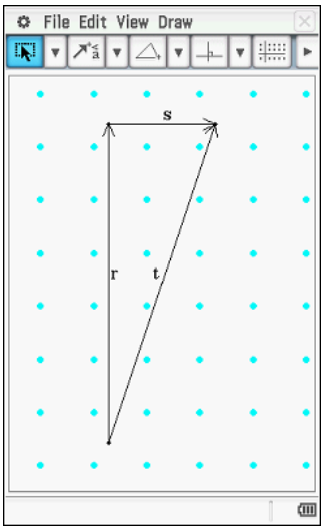
Setup

- Open the Geometry application
- Select [File | New]
- Select [| Geometry Format] and set
  Measure Angle to Degrees
  Axes to Off and
  Grid to On



Draw the vectors

- Construct a vector **r** from bottom to top of screen. Constrain the length to 6 and the direction to 90°. This represents the still water velocity of the boat.
- Construct a vector **s** from left to right of screen. Constrain the vector to 2 units long and direction to 0°. This will represent the current.
- Select [View | Zoom to Fit].
- Construct a vector **t** from the tail of **r** to the head of **s**. This is the resultant of the boat's still-water velocity and the velocity of the current.
  (i.e. **r** + **s** = **t**).

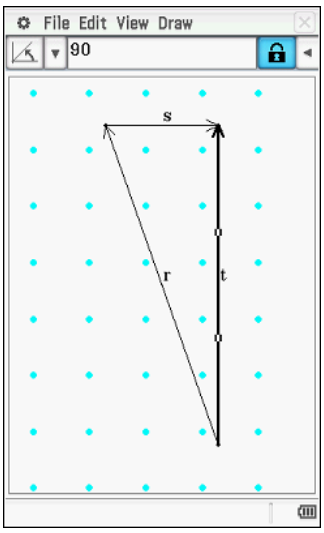


1.

a) Determine the resultant velocity (magnitude and direction).

Set resultant to 90 (straight across the river)

- Tap to select **r**
- With direction selected, tap to remove the constraint
  (We no longer require the boat to be pointed directly across the river)
- Select **t**
- Constrain its direction to 90˚



b) To travel directly across the river, determine the:

(i) direction in which the bow of the boat should be directed, and

(ii) the time taken to cross the river.

Problem 2

A light aircraft has a still-air top speed of 250 km/h. A pilot wishes to fly the plane directly to an airport 300 km away on a bearing of 060˚. There is a wind blowing at a constant 75 km/h from a bearing of 310˚. On what bearing should the pilot point the plane and how long will the journey take?

Detailed instructions for the construction can be found in the Learning notes.

2. Determine the bearing on which the pilot should point the plane and the time taken to complete the journey.

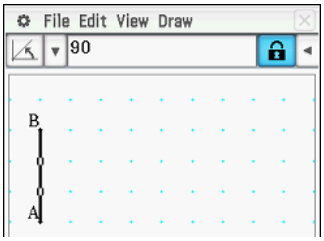
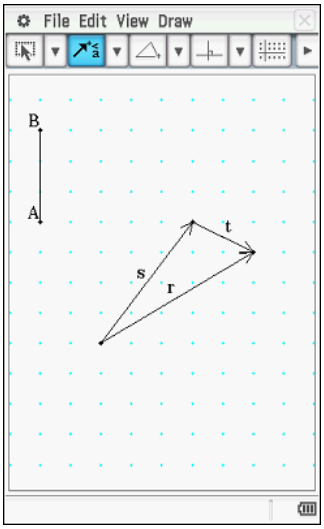
3. If the pilot wishes to complete the return journey, determine the bearing on which to set the plane and the time to complete the journey. Draw a clearly labelled diagram below to assist you.

Learning notes

Vector labels can be changed for clarity. Select a vector then select label [A] from the Measure pull down menu.

Solving **Problem 1** using the ClassPad Geometry application is perhaps not as efficient as solving it manually; however, the idea of constructing scale diagrams using velocity vectors enables far more complex problems to be solved with relative ease.

Problem 2 Construction

Open a new Geometry page • select [File | New] **Construct north-south line** • Draw a small line segment $\overline{AB}$ in the top left corner • Constrain its angle to 90°	
Construct resultant velocity • Draw vector **r** • Select **r** and $\overline{AB}$ and constrain the angle between them [∠] to 60° **Construct vector for the plane's still-air velocity** • Construct vector **s** from the tail of **r** to somewhere above it **Construct vector for the wind velocity** • Construct vector **t** from the head of **s** to the head of **r**. (i.e. **s** + **t** = **r**)	
Set constraints • Select **s** and constrain its length to 250 • Select **t** and constrain its length to 75 • Select **t** and $\overline{AB}$ and constrain the supplementary angle between them [↻] to 130° (310–180) • Select [View | Zoom to Fit]	