Boats and Airplanes

Speed problems for boats and airplanes have a specialty, because boats travel in water and airplanes travel in air.

What you see while standing on the ground as a boat's or airplane's speed is quite different from what the sailor or the pilot sees. What you see from the ground depends on the speed and the direction of the current in the river or the speed and the direction of the wind.

In physics, this idea is called the principle of relative velocity.

Before we jump into the math, we need a naming convention to keep things in order.

Boat Problem

For a boat, let's name the three speeds as follows:

Speed of boat with respect to river as seen by the sailor is V(boat/river)
Speed of the river current as seen from the ground is V(river/ground)
Speed of the boat as seen from the ground is V(boat/ground)

The relationship among these three speeds is

$$V(\text{boat/ground}) = V(\text{boat/river}) + V(\text{river/ground})$$

This relationship is pretty simple, but it has some hidden complications. Let's say, a sailor is rowing his boat toward east, but the river current is toward west. In this case, the "+" sign in the relation above has to be changed into negative sign.

Let's rewrite the relation as follows:

$$V(\text{boat/ground}) = V(\text{boat/river}) \ (+ \text{ or } -) \ V(\text{river/ground})$$

with the understanding that we will use the " + " sign when the boat and the river are going in the same direction; and " – " sign when they are going in opposite directions.

Key Issues:
#1 Use + sign when the boat is traveling along the current
#2 Use – sign when the boat is traveling against the current

#3 When any two speeds are given, we can find the third speed from the relation

Airplane Problem

The three speeds in the airplane problem are:

Speed of airplane with respect to air as seen by the pilot is V(plane/air)
Speed of the wind as seen from the ground is V(air/ground)
Speed of the airplane as seen from the ground is V(plane/ground)

The relationship among these speeds is

$$V(\text{plane/ground}) = V(\text{plane/air}) \ (+ \text{ or } -) \ V(\text{air/ground})$$

with the understanding that we will use the " + " sign when the airplane and the wind are going in the same direction; and " – " sign when they are going in opposite directions.

Key Issues:
#1 Use + sign when the airplane is flying along the wind
#2 Use – sign when the airplane is flying against the wind
#3 When any two speeds are given, we can find the third speed from the relation

Question: Do we need to apply the principle of relative velocity to a car or a train traveling in a wind?

Answer: No! A car or a train is in contact with the ground. The speed the driver or the engineer sees on the speedometer is the speed of the car or the train.