

## Physics 20 Unit 1 - Vectors

# Relative Motion: Navigational Problems



# Relative Motion

- motion measured with respect to an outside observer.

**ex) A fly traveling in a car buzzes at 5.0 m/s forward. The car travels at 25 m/s forward. What is the velocity of the fly:**

**a) Relative to an observer in the car?**

**b) Relative to an observer on the street?**

**c) If the fly turns around and flies with the same speed, what is his velocity relative to an observer on the street?**

**One situation where we will encounter relative velocities is in air travel.**

**Terms to remember**

- **Ground velocity: the velocity of the air craft relative to the ground.**
- **Air velocity: the velocity of the air craft relative to still air.**
- **Wind velocity: the velocity of the wind relative to the ground.**

**Now let's try a problem on...**

**ex) A jet has an air velocity of 800 km/h [W]. A cross-wind of 52 km/h [S]. What is the ground velocity of the jet?**



Notice in the last question that the **resultant was the hypotenuse** of the triangle. The jet was pushed off course by the wind.

**What if the jet wanted to fly exactly West? What angle would it need to head out in to have a resultant due West?**

**In a problem such as this, the resultant is not the hypotenuse!**

**ex) The same jet wants to fly directly [W]. The air velocity and wind velocity remains the same. What angle must the jet start off at and what will its resultant velocity be?**



**ex) A boat is attempting to reach a point directly south from it's starting point in a river with cross current of 10 m/s [E]. If the boat has a water velocity of 50 m/s, at what angle should the boat point to sail directly across?**

## **Navigational Problems with Velocity and Displacement**

**Sometimes, problems give info about velocity and displacement. In these cases, it is wise to draw separate diagrams for each variable.**

**ex) A boat is traveling North at 15 m/s across a 150 m wide river. The river has a current of 2.0 m/s West. How far downstream does the boat drift when crossing this river?**



## 1. Velocity Diagram

## 2. Displacement Diagram

**b) How long is the boat in the water for?**

**Hint: Always use velocities and displacements acting in the same direction.**