
# 1.10 Relative Motion - Navigational Problems

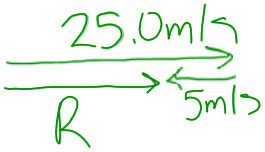
Relative Motion - motion measured with respect to an outside observer.

Ex.) A fly travelling 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? 5.0 m/s

b) Relative to an observer on the street? 30.0 m/s

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

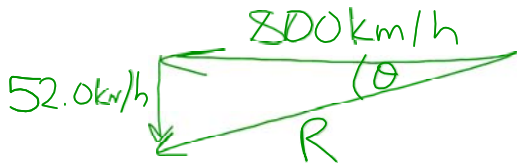



R = 20.0 m/s [For]


Air travel is often used as an example of relative motion. Some terms to remember are (pg. 92):

- 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.


Ex.) A jet has an air velocity of 800 km/h [W]. There is a cross-wind of 52.0 km/h [S]. What is the ground velocity of the jet?

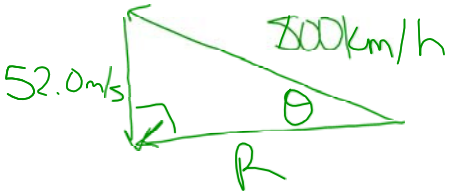



$R = \sqrt{52.0^2 + 800^2} = 802 \text{ km/h}$

$\tan\theta = \frac{52.0}{800} = 4°$

$R = 802 \text{ km/h } [4° \text{ SofW}]$


Ex.) The same jet wants to fly directly West. The air velocity and wind velocity remain the same. What angle must the jet start off at and what will the resultant velocity be?

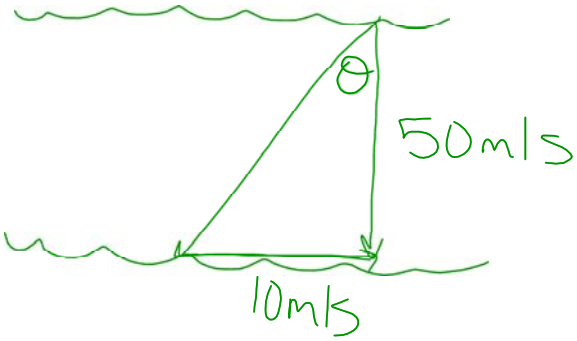



$R = \sqrt{800^2 - 52.0^2} = 798 km/h$

$\sin\theta = \frac{52.0}{800} \quad \theta = 4°$

$R = 798 km/h [4° N of W]$


Ex.) A boat is attempting to reach a point directly South from its starting point in a river with cross current of 10 m/s [E]. If the boat has a ground velocity of 50 m/s, at what angle should the boat point to sail directly across?

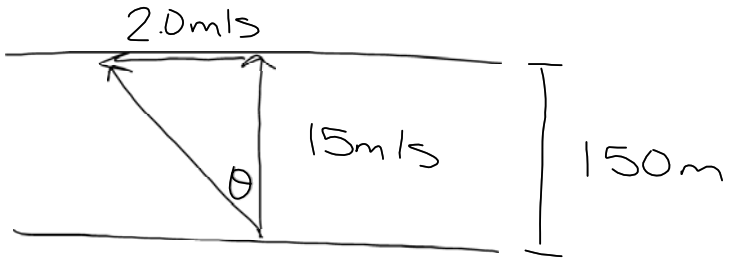


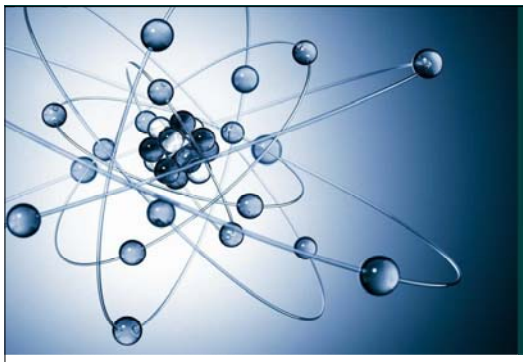

$\tan\theta = \frac{10}{50}$

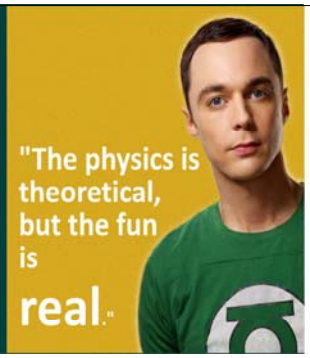
$\theta = 11^\circ$ W of S


If a problem gives you information about velocity and displacement then it's wise to draw two separate diagrams:

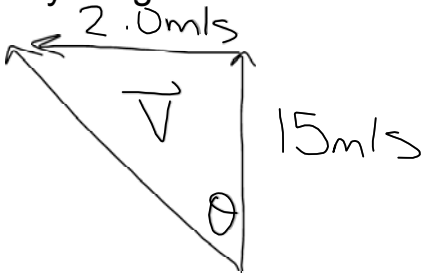
Ex.) A boat is travelling North at 15 m/s across a 150 m wide river. The river has a current of 2.0 m/s West. How far downstream does the boat drift when crossing this river?





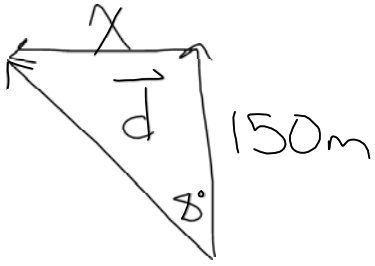



1. Velocity Diagram:




$\tan\theta = \frac{2.0\,m/s}{15\,m/s}$ $\theta = 8°$

2. Displacement Diagram:




$\tan 8° = \frac{x}{150}$

$x = 20m\,[W]$


b) How long will the boat be in the water for?

$$t = \frac{\vec{d}}{\vec{v}} = \frac{150\,m}{15\,m/s} = \boxed{10\,s}$$

$$= \frac{20\,m}{2.0\,m/s} = \boxed{10\,s}$$

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

Pg. 101 # 5-11.