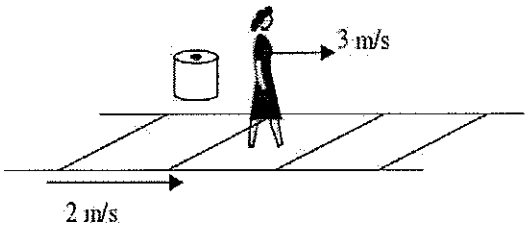
Relative Motion

1. An moving walkway at the airport has a velocity of 2 m/s to the right. A person walks at a steady pace of 3 m/s.



   A. If the person is walking to the right, what is their velocity relative to the walkway? 3 m/s

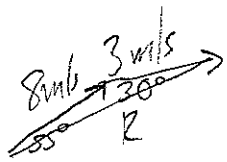
   B. What is their velocity relative to the ground? 5 m/s

   C. How long would it take them to travel to the food court, 100 m away? $s = d/t$
   s 5 m/s, d 100 m, t ? $t = d/s = \frac{100\text{m}}{5\text{m/s}} = 20\text{s}$

   D. How long would it take them to walk back if they have to walk on the same walkway?
   $2\text{m/s} + -3\text{m/s} = 1\text{m/s}$, $d = 100\text{m}$, $s = d/t$
   $t = d/s = \frac{100\text{m}}{1\text{m/s}} = 100\text{s}$

   E. How long would it take them to walk to the food court and back without using the walkway?
   $d = 200\text{m}$, $t = ?$, $s = 3\text{m/s}$, $s = d/t$, $t = d/s$
   $t = \frac{200\text{m}}{3\text{m/s}}$ $t = 66.7\text{s}$

2. A toy plane's is flying 55° going 8 m/s. If the wind is pushing with a velocity of 3 m/s at 30°, find the total velocity and direction of plane.

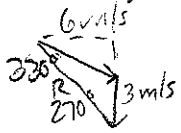


V_1 $x = hyp\cos\theta$
$= 8\text{m/s}\cos 55°$
$= 4.6\text{m/s}$
$y = hyp\sin\theta$
$= 8\text{m/s}\sin 55°$
$= 6.6\text{m/s}$

V_2 $x = 3\text{m/s}\cos 30°$
$= 2.6\text{m/s}$
$y = 3\text{m/s}\sin 30°$
$= 1.5\text{m/s}$
$x_{tot} = 7.2\text{m/s}$
$y_{tot} = 8.1\text{m/s}$

$x^2 + y^2 = R^2$
$(7.2\text{m/s})^2 + (8.1\text{m/s})^2 = R^2$
$R = 10.8\text{m/s}$
$\theta = \tan^{-1}\frac{y_t}{x_t} = \frac{8.1\text{m/s}}{7.2\text{m/s}}$
$\theta = 48.4°$

3. A boat is traveling 6 m/s at an angle of –30°. The water has a current flowing 3 m/s directly south. Find the boat's total velocity and direction.



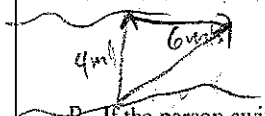
V_1 $x = hyp\cos\theta$
$= 6\text{m/s}\cos 330°$
$= 5.2\text{m/s}$
$y = -3\text{m/s}$ $y = hyp\sin\theta$
$6\text{m/s}\sin 330°$

V_2 $x = 0\text{m/s}$
$y = 3\text{m/s}$
$x_t = 5.2\text{m/s}$
$y_t = -6\text{m/s}$

$x^2 + y^2 = R^2$
$(5.2\text{m/s})^2 + (-6\text{m/s})^2 = R^2$
$R = 7.9\text{m/s}$
$\theta = \tan^{-1}\frac{y_t}{x_t}$
$= \frac{-6\text{m/s}}{5.2\text{m/s}}$ $\theta = -49°$ or $310.9°$

4. A person can swim 4 m/s. The river has a current flowing 6 m/s directly east.

   A. What will be the direction and velocity of the person if they aim directly across the river (north)?



$x^2 + y^2 = c^2$
$(4\text{m/s})^2 + (6\text{m/s})^2 = R^2$
$R = 7.2\text{m/s}$
$\theta = \tan^{-1}\frac{4\text{m/s}}{6\text{m/s}} = 33.7°$

   B. If the person swims at constant speed, how long does it take them to swim across the 40 m wide river?
   $s = d/t$, $t = d/s$
   s 4 m/s, d 40 m, t ?
   $t = \frac{40\text{m}}{4\text{m/s}}$ $t = 10\text{s}$
   Since x & y are independent, the river current won't change t, only final pos.

   C. How far downstream will the person drift?
   $t = 10\text{s}$, $v = 6\text{m/s}$, $d = ?$, $d = v \cdot t$
   $10\text{s} \cdot 6\text{m/s} = 60\text{m}$

   D. At what direction will the person have to swim to reach a point directly across the river?
   not possible.
   why?
   6m/s, 4m/s, ?
   the hypothesis cannot be smaller than a side

   E. If the river's current increases (is faster), will the person take more or less time to cross the river?
   same time