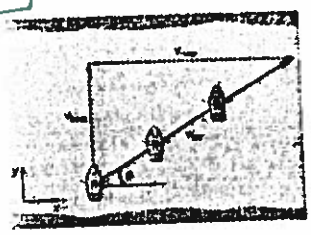
* Person * Ground
* Boat
* Current

$\vec{V}_{PG} = \vec{V}_{PB} + \vec{V}_{BC} + \vec{V}_{CG}$ $\quad \vec{V}_{PG} = -\vec{V}_{GP}$ *

SPH4U **Relative Velocity- Sample Questions** Date:_____



Using the Chain Rule in One Dimension!

1. a) A person is walking East at 5.0 km/h relative to train which is travelling at 42.0 km/h [East].
What is the person's velocity relative to the ground?

p-person t-train g-ground

$\vec{V}_{PT} = 5.0\ km/h\ [E]$

$\vec{V}_{TG} = 42.0\ km/h\ [E]$

$\vec{V}_{PG} = ?$ Let → E +

$\vec{V}_{PG} = \vec{V}_{PT} + \vec{V}_{TG}$

$= 5.0\ km/h + 42.0\ km/h$

$= 47.0\ km/h\ [E]$

b) What is the person's velocity relative to the ground if the person is walking at 5.0 km/h West relative to the train?

W = −

$\vec{V}_{PT} = 5.0\ km/h\ [W]$

$\vec{V}_{PG} = ?$

$\vec{V}_{PG} = \vec{V}_{PT} + \vec{V}_{TG}$

$= -5.00\ km/h + 42.0\ km/h$

$= +37.0\ km/h \approx 37.0\ km/h\ [E]$

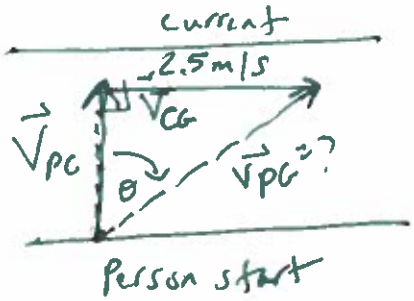
2-D River Crossing Question:

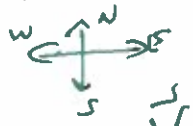
2. A swimmer who can swim at 4.0 m/s in still water, heads north as they swim across a river with a current of 2.5 m/s East.

a) Approximately where will the swimmer land relative to their starting position?

NE of their starting position

b) What is their resultant velocity relative to shore?





p-person c-current g-ground

$\vec{V}_{PC} = 4.0\ m/s\ [N]$

$\vec{V}_{CG} = 2.5\ m/s\ [E]$

$\vec{V}_{PG} = ?$

Analysis:

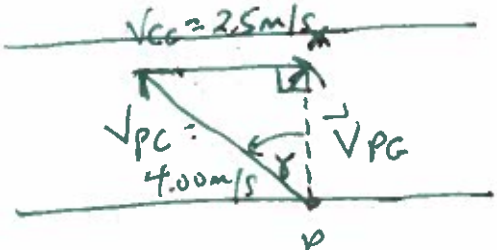
$\vec{V}_{PG} = \vec{V}_{PC} + \vec{V}_{CG}$

$V_{PG} = \sqrt{4.0^2 + 2.5^2} = 4.7\ m/s$

$\theta = \tan^{-1}\left(\frac{2.5}{4.0}\right) = 32.0°$

$\vec{V}_{PG} = 4.7\ m/s\ [N\ 32°\ E]$

c) In what direction would the swimmer have to head in order to swim directly NORTH across the river?



$\vec{V}_{CG} = 2.5\ m/s\ [E]$

$\vec{V}_{PC} = 4.0\ m/s\ [?]$

$\vec{V}_{PG} = ?\ [N]$

Analysis:

$\vec{V}_{PG} = \vec{V}_{PC} + \vec{V}_{CG}$

$\sin\gamma = \frac{2.5}{4.0}$ $\quad \gamma = \sin^{-1}\left(\frac{2.5}{4.0}\right)$

$= 39°$

$V_{PG} = \sqrt{4.0^2 - 2.5^2}$

$= 3.1\ m/s$

* Her heading is [N 39° W]

$+\vec{V}_{PG} = 3.1\ m/s\ [N]$,

Airplane Navigation Question → East!!

The displacement from Toronto to Houston, Texas is 1.55 x 10 ^{3} km [S 35.0° W]. There is a wind of 115 km/h from the west. If a pilot wants to fly directly between the two cities in a time of 3.00 hours, what velocity relative to air must she maintain?

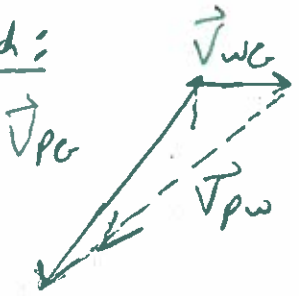
p-plane w-wind g-ground

$\vec{\Delta d}_{PG} = 1.55 \times 10^3$ Km [S 35.0° W]

$\vec{V}_{WG} = 115$ Km/h [E]

$\Delta t = 3.00$ h

Sketch:



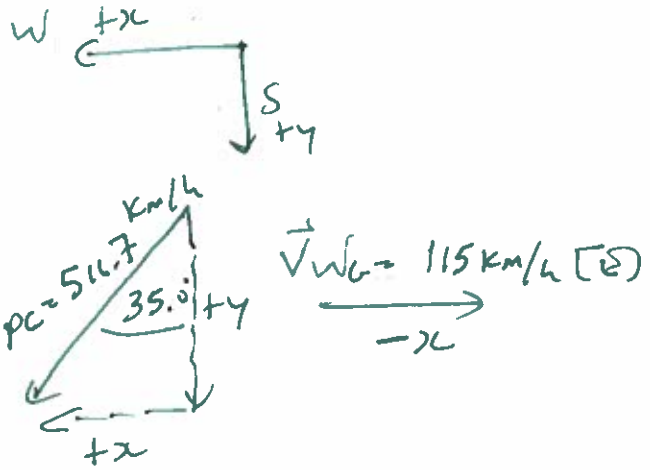
$\vec{V}_{PG} = \frac{\Delta \vec{d}_{PG}}{\Delta t} = \frac{1.55 \times 10^3 \text{ Km}}{3.00 \text{ h}} = 516.7$ Km/h [S 35.0° W]

$\vec{V}_{PW} = ?$

Analysis: $\vec{V}_{PG} = \vec{V}_{PW} + \vec{V}_{WG}$

$\vec{V}_{PW} = \vec{V}_{PG} - \vec{V}_{WG}$

≡



X

$V_{PW_x} = V_{PG_x} - V_{WG_x}$

$= 516.7 \sin 35.0° - (-115.0)$

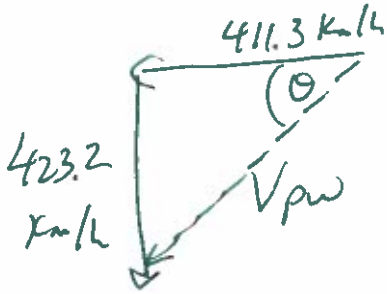
$= 411.3$ Km/h

Y

$V_{PW_y} = V_{PG_y} - V_{WG_y}$

$= 516.7 \cos 35.0° - 0$

$= 423.2$ Km/h



$V_{PW} = \sqrt{411.3^2 + 423.2^2} = 590.2$ Km/h

$\theta = \text{Tan}^{-1}\left(\frac{423.2}{411.3}\right) = 45.8°$

$\therefore \vec{V}_{PW} = 590$ Km/h [W 45.8° S]