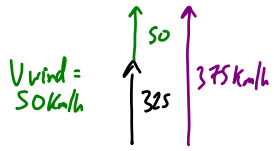
Worksheet 3.1 – Independence of Perpendicular Vectors

1. A plane is flying round trip to an destination 250 km North of its starting point. The plane flies with an airspeed of 325 km/h and the wind is blowing at 50.0 km/h due North.
a) How long does it take to get to the destination? b) How long does it take to return to the starting point?

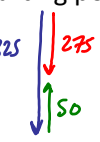
a.) $V_{plane} = 325$ km/h ↑, $V_{wind} = 50$ km/h ↑



$V = \frac{d}{t}$

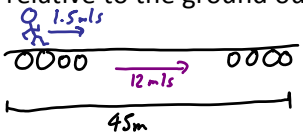
$t = \frac{d}{V} = \frac{250\text{ km}}{375\text{ km/h}} = 0.67\text{ h}$

b.)



$t = \frac{d}{V} = \frac{250\text{ km}}{275\text{ km/h}} = 0.91\text{ h}$

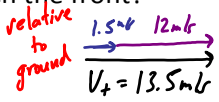
2) A tourist starts at the back of train that is 45 m long and walks towards the front at 1.5 m/s. The train is moving at 12 m/s.
a) How long does it take for the tourist to reach the front of the train, and how far has the tourist moved relative to the ground outside the train by the time they reach the front?



relative to train: $V = \frac{d}{t}$

$t = \frac{d}{V} = \frac{45\text{m}}{1.5\text{m/s}} = \boxed{30.\text{ s}}$

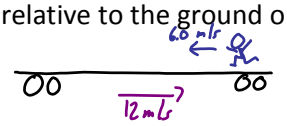
relative to ground:



$V_t = 13.5$ m/s

$d = V \cdot t$
$= (13.5\text{ m/s})(30\text{ s})$
$= 405\text{ m} = \boxed{410\text{ m}}$

b) If the tourist decides to run all the way back to the end of the train at 6.0 m/s, how far have they travelled relative to the ground outside in this time?



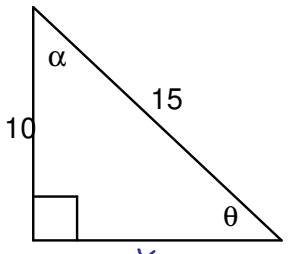
relative to train: $t = \frac{d}{V} = \frac{45\text{m}}{6.0\text{m/s}}$

$= 7.5\text{ s}$

relative to ground:

$d = V \cdot t = (6.0\text{m/s})(7.5\text{s})$
$= 45\text{m}$

3) Solve the following triangles (**all sides and angles**) using SOH – CAH - TOA and Pythagoras



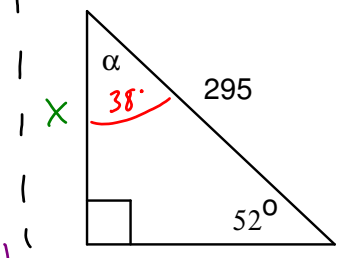
$x = \sqrt{15^2 - 10^2}$

$= 11.2\text{ m}$

$\alpha = \cos^{-1}\left(\frac{10}{15}\right)$

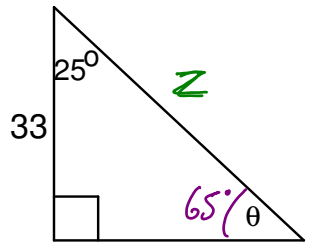
$= 48°$

$\theta = 180 - 48 = 42°$



$x = 295 \sin 52° = 232$

$y = 295 \cos 52° = 182$

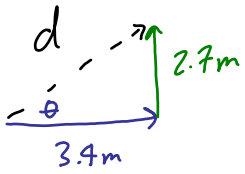


$x = 33 \tan 25° = 15$

$z = \frac{33}{\sin 65°} = 36$

4) Add the following x and y vectors, draw the **resultant** vector and solve its **magnitude and direction.**

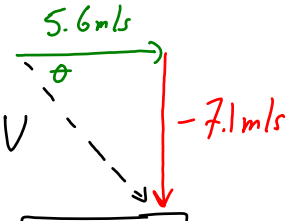
a) x: 3.4 m y: 2.7 m



$d = \sqrt{3.4^2 + 2.7^2} = 4.3\text{m}$

$\theta = \tan^{-1}\left(\frac{2.7}{3.4}\right) = 38°\text{ N of E}$

b) x: 5.6 m/s y: -7.1 m/s

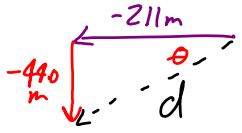


$V = \sqrt{5.6^2 + 7.1^2}$

$= 9.0\text{ m/s}$

$\theta = \tan^{-1}\left(\frac{7.1}{5.6}\right) = 52°\text{ S of E}$

c) x: -211 m y: -44.0 m



$d = \sqrt{44^2 + 211^2}$

$= 216\text{ m}$

$\theta = \tan^{-1}\left(\frac{44}{211}\right)$

$= 12°\text{ S of W}$