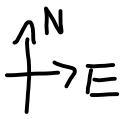
If **A** = 28 m [E75°N], **B** = 35 m [E24°S], **C** = 22 m [W50°N], and **D** = 40 m [W30°S] Find:

b. 4C + 3D {160 m [W2.6°N]}



Components

$C_E = -22\cos 50° = -14.1\text{m}$

$C_N = +22\sin 50° = +16.9\text{m}$

$D_E = -40\cos 30° = -34.6\text{m}$

$D_N = -40\sin 30° = -20\text{m}$

East Calculation

$R_E = 4C_E + 3D_E$

$= 4(-14.1) + 3(-34.6)$

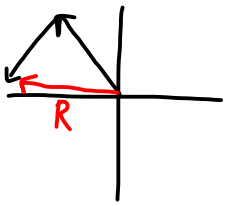
$= -160.2\text{ m}$

North Calculation

$R_N = 4C_N + 3D_N$

$= 4(16.9) + 3(-20)$

$= +7.6\text{ m}$



Resultant

$R = \sqrt{R_E^2 + R_N^2} = 160.4\text{ m}$

$\theta = \tan^{-1}\left|\frac{R_N}{R_E}\right| = \tan^{-1}\left|\frac{7.6}{-160.2}\right|$

$\theta = 2.7°$

$\vec{R} = 160.4\text{m}\ [\text{W } 2.7° \text{ N}]$

d. $2D - C$ {79.2 m [W46°S]}

$C = 22\text{ m}\,[W50°N]$ $D = 40\,[W30S]$

Components

$C_E = -22\cos 50° = -14.1\text{m}$

$C_N = +22\sin 50° = +16.9\text{m}$

$D_E = -40\cos 30° = -34.6\text{m}$

$D_N = -40\sin 30° = -20\text{m}$

East

$R_E = 2D_E - C_E$

$= 2(-34.6) - (-14.1)$

$= -69.2 + 14.1 = -55.1\text{m}$ west

North

$R_N = 2D_N - C_N$

$= 2(-20) - (16.9)$

$= -40 - 16.9 = -56.9\text{m}$ south

$\vec{R} = \sqrt{R_E^2 + R_N^2} = \sqrt{(-55.1)^2 + (-56.9)^2}$

$\vec{R} = 79\text{m}$ $\theta = \tan^{-1}\left|\frac{R_N}{R_E}\right|$

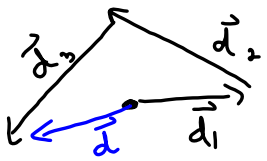
$\theta = \tan^{-1}\left|\frac{-56.9}{-55.1}\right| = 46°$

$\vec{R} = 79\text{m}\,[W46°S]$

Physics 122: Application of Vectors Examples

1. What is the average velocity of a car that drives 66 km [E], 52 km [W33°N], and 45 km [W73°S] in 3.1 hours?

$$\vec{v}_{avg} = \frac{\vec{d}}{t}$$



$\vec{d}$ = vector sum of all three vectors.

$$\vec{d} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3$$

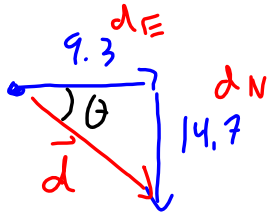
$d_{1E} = 66\cos\theta = 66\ km$ $\quad d_{1N} = 66\sin\theta = 0\ km$

$d_{2E} = -52\cos 33 = -43.6\ km$ $\quad d_{2N} = +52\sin 33 = 28.3$

$d_{3E} = -45\cos 73 = -13.1$ $\quad d_{3N} = -45\sin 73 = -43$

$$d_E = d_{1E} + d_{2E} + d_{3E}$$
$$= 66 - 43.6 - 13.1 = 9.3\ km$$

$$d_N = d_{1N} + d_{2N} + d_{3N}$$
$$= 0 + 28.3 - 43 = -14.7\ km$$



$$\vec{d} = \sqrt{d_E^2 + d_N^2}$$
$$= \sqrt{(9.3)^2 + (-14.7)^2}$$
$$= 17.4\ Km$$

$$\theta = \tan^{-1}\left|\frac{d_N}{d_E}\right| = \tan^{-1}\left|\frac{-14.7}{9.3}\right| = 58°$$

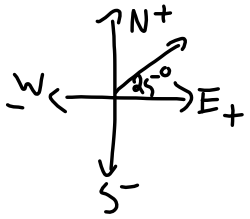
$$\vec{d} = 17.4\ Km\ [E\ 58°S]$$

$$\vec{v}_{avg} = \frac{\vec{d}}{t} = \frac{17.4\ Km\ [E\ 58°S]}{3.1\ h}$$

$$= 5.6\ \frac{Km}{h}\ [E\ 58°S]$$

10. A glider is flying 9.2 m/s [E25°N]. A gust of wind changes the glider's trajectory to 11 m/s [E14°S] in 7.9 seconds.
    a. What was the acceleration of the glider? {a = 0.88 m/s^2 [E70°S]}
    b. What was the displacement of the glider during that time? {d = 75 m [E3.7°N]}
    c. What was the average force if the glider has a mass of 55 kg? {F = 48 N [E70°S]}

$$a = \frac{v_f - v_0}{t}$$



$v_0 = 9.2\,m/s\ [E\ 25°N]$

$v_f = 11\,m/s\ [E\ 14°S]$

$t = 7.9\,s$

$$a_E = \frac{v_{fE} - v_{0E}}{t}$$

$v_{0E} = 9.2\cos 25$

$= 8.33\,m/s$

$v_{fE} = 11\cos 14$

$= 10.7\,m/s$

$$a_E = \frac{10.7 - 8.33}{7.9}$$

$= 0.3\,m/s^2$

$$a_N = \frac{v_{fN} - v_{0N}}{t}$$

$v_{0N} = 9.2\sin 25°$

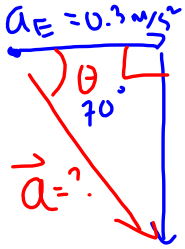
$= 3.89\,m/s$

$v_{fN} = -11\sin 14°$

$= -2.66\,m/s$ ↖ south

$$a_N = \frac{-2.66 - 3.89}{7.9}$$

$a_N = -0.83\,m/s^2$



$a_N = -0.83\,m/s^2$

$$|a| = \sqrt{(a_E)^2 + (a_N)^2} = \sqrt{(0.3)^2 + (-0.83)^2}$$

$|a| = 0.88\,m/s^2 \quad \theta = \tan^{-1}\left|\frac{a_N}{a_E}\right|$

$$\theta = \tan^{-1}\left|\frac{-0.83}{0.3}\right| = 70°$$

$\vec{a} = 0.88\,m/s^2\ [E\ 70°\ S]$

10 b) $\vec{d} = ?$ $\quad d_f = d_o + v_o t + \frac{1}{2} a t^2$

($d_o \leftarrow 0$)

$d_{fE} = ?$ $\quad d_{fN} = ?$ $\quad d_f = \sqrt{(d_{fE})^2 + (d_{fN})^2}$

$d_{fE} = d_{oE} + v_{oE} t + \frac{1}{2} a_E t^2$

$= 0 + (8.33)(7.9) + \frac{1}{2}(0.3)(7.9)^2$

$= 75.2\ m$

$d_{fN} = d_{oN} + v_{oN} t + \frac{1}{2} a_N t^2$

$= 0 + (3.89)(7.9) + \frac{1}{2}(-0.83)(7.9)^2$

$= 4.83\ m$

$|d_f| = \sqrt{(75.2)^2 + (4.83)^2} = 75\ m$

$\theta = \tan^{-1}\left(\frac{4.83}{75.2}\right) = 3.7°$

$d_f = 75\ m\ [E\ 3.7°\ N]$

(c) $\vec{F} = m\vec{a}$

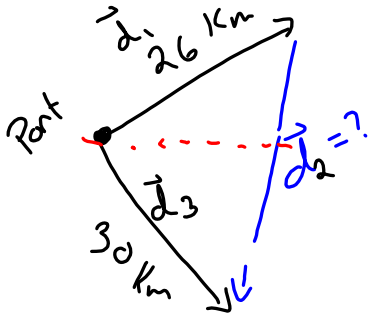
$= (55\ kg)(0.88\ [E\ 70°\ S])$

$= 48\ N\ [E\ 70°\ S]$

Physics 122: Application of Vectors Examples

8. An inept boating tour guide takes you to a point 26 km [E33°N] from port when in fact you should be located 30 km [E33°S]. To get to your proper destination in 0.75 hours, with what velocity should the tour boat travel?

$\vec{v}_{avg} = \frac{\vec{d}}{t}$



$\vec{d}_3 = \vec{d}_1 + \vec{d}_2$.

$\vec{d}_2 = \vec{d}_3 - \vec{d}_1$

$d_{3E} = 30\cos 33$
$= 25.2$ km

$d_{3N} = -30\sin 33$
$= -16.3$ km

$d_{1E} = 26\cos 33$
$= 21.8$ km

$d_{1N} = 26\sin 33$
$= 14.2$ km

$d_{2E} = d_{3E} - d_{1E}$
$= 25.2 - 21.8$
$= 3.4$ km
East

$d_{2N} = d_{3N} - d_{1N}$
$= -16.3 - 14.2$
$= -30.5$ km
$= 30.5$ km South

$d_2 = \sqrt{d_{2E}^2 + d_{2N}^2} = \sqrt{(3.4)^2 + (-30.5)^2}$
$= 30.7$ km

$\theta = \tan^{-1}\left|\frac{d_{2N}}{d_{2E}}\right| = \tan^{-1}\left|\frac{30.5}{3.4}\right| = 84°$

$\vec{d}_2 = 30.7$ km [E 84° S]

$\vec{v}_{avg} = \frac{\vec{d}}{t} = \frac{30.7}{0.75} = 40.9$ km/h [E 84° S]

Test tomorrow

#6, 16, 20

YouTube