2D KINEMATICS – PRACTICE

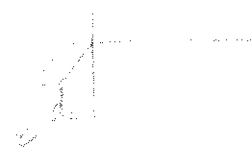
1. A jogger runs at 8.5 km/h for 30.0 minutes due north. After 30.0 minutes he speeds up to 10.2 km/h and keeps the pace for 40.0 minutes while running 30° south of west. At the end the jogger walks briskly at 5.8 km/h for 12 minutes towards a coffee shop due east 22° north.

- Find the Jogger's final displacement (in vector notation, its magnitude and direction).

$v_1 : \frac{8.5\ km}{h} \times \frac{1000\ m}{1\ km} \times \frac{1\ h}{3600\ s} = 2.36\overline{1}\ m/s$

$v_2 : \frac{10.2\ km}{h} \times \frac{1000\ m}{1\ km} \times \frac{1\ h}{3600\ s} = 2.83\ m/s$

$v_3 : \frac{5.8\ km}{h} \times \frac{1000\ m}{1\ km} \times \frac{1\ h}{3600\ s} = 1.6\overline{1}\ m/s$



$\vec{d}_1 = (2.36\overline{1})(30)(60) = 4250\ m\ [N]$

$\vec{d}_2 = (2.8\overline{3})(40)(60) = 6800\ m\ [W\ 30°\ S]$

$\vec{d}_3 = (1.6\overline{1})(12)(60) = 1160\ m\ [E\ 22°\ N]$

$\vec{d}_f = [\ldots] + [-5889, -3400] + [1076, 435]$

$= [-4813, 1285]\ m$

$\|\vec{d}_f\| = \sqrt{4813^2 + 1285^2}$

$= 4975\ m$

$= 5.0 \times 10^3\ m$

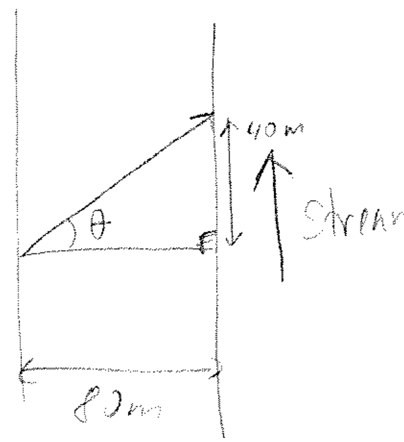
∴ Jogger's final displacement is $5.0 \times 10^3\ m$ W 15° N.

$\theta = \tan^{-1}\left(\frac{1285}{4813}\right)$

$= 15°$

2. A swimmer heads directly across a river swimming at 1.6 m/s relative to still water. She arrives at a point 40.0 m downstream from the point directly across the river, which is 80.0 m wide. Determine:

- Speed of the current
- The magnitude of the swimmer's resultant velocity
- The direction of the swimmer's resultant velocity
- The time it takes the swimmer to cross the river



$v_s = 1.6$ m/s

- time to cross the river: $t = \frac{d}{v}$

$t = \frac{80}{1.6}$

$t = 50$ s

- time the current needs to carry the swimmer 40.0 m is the same as the time the swimmer needs to swim across the river: $t = 50$ s

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

$v_c = \frac{40.0}{50.0}$

$v_c = 0.80$ m/s

- Swimmers resultant velocity:

$\vec{v} = \frac{\vec{d}}{t} = \frac{[80, 40]\text{ m}}{50 \text{ s}}$

$= \frac{1}{50}[80, 40]$ m/s

$= [1.6, 0.80]$ m/s

$\|\vec{v}\| = \sqrt{1.6^2 + 0.80^2}$

$\doteq 1.8$ m/s

$\theta = \tan^{-1}\left(\frac{0.80}{1.6}\right)$

$\theta \doteq 27°$

↑ magnitude

↑ direction