Answers

PHYSICS 12

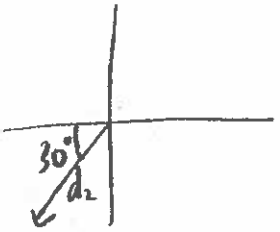
2D KINEMATICS – PRACTICE

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

v_2 : $\frac{10.2\text{ km}}{\text{h}} \times \frac{1000\text{ m}}{1\text{ km}} \times \frac{1\text{ h}}{3600\text{ s}} = 2.8\bar{3}\text{ m/s}$

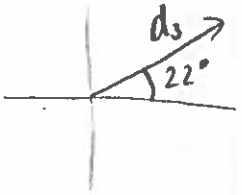
v_3 : $\frac{5.8\text{ km}}{\text{h}} \times \frac{1000\text{ m}}{1\text{ km}} \times \frac{1\text{ h}}{3600\text{ s}} = 1.6\bar{1}\text{ m/s}$



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

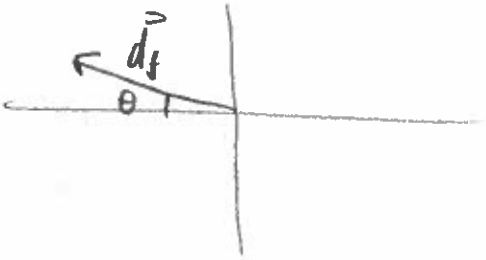
$\vec{d}_2 = (2.8\bar{3})(40)(60) = \underline{6800\text{ m [W 30°S]}}$

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



$\vec{d}_f = [0, 4250] + [-5889, -3400] + [1076, 435]$

$= [-4813, 1285]\text{ m}$



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

$= 4975\text{ m}$

$= \underline{5.0 \times 10^3\text{ m}}$

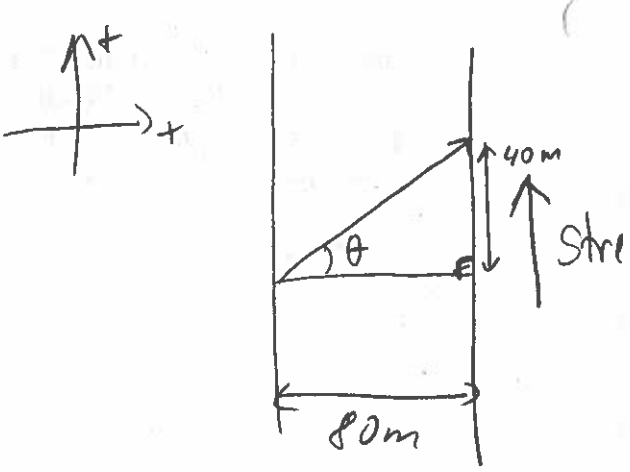
∴ Jogger's final displacement is 5.0×10^3 m W 15° N.

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

$= 15°$

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:

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

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

$$= [1.6, 0.80]\ m/s$$

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

$$\div 1.8\ m/s$$

↑ magnitude

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

$$\theta \doteq 27°$$

↑ direction