Answers

PHYSICS 12

2D KINEMATICS – PRACTICE

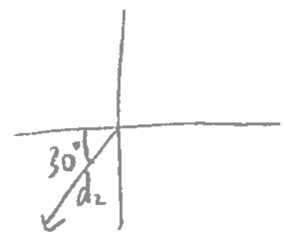
1. A jogger runs at 8.5 km/h for 30.0 minutes due north. After 30.0 minutes he speeds up to 10.2 km/h and keeps the pace for 40.0 minutes while running 30° south of west. At the end the jogger walks briskly at 5.8 km/h for 12 minutes towards a coffee shop due east 22° north.

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

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

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

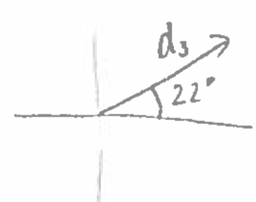
$$v_3: \frac{5.8\text{ km}}{\text{h}} \times \frac{1000\text{ m}}{1\text{ km}} \times \frac{1\text{ h}}{3600\text{ s}} = 1.6\bar{1}\text{ m/s}$$



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

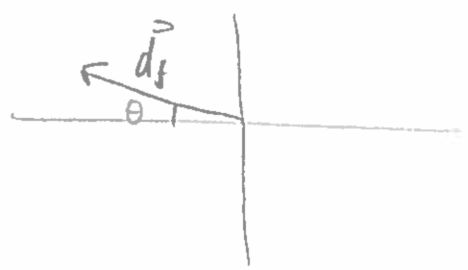
$$\vec{d}_2 = (2.8\bar{3})(40)(60) = 6800\text{ m [W 30° S]}$$

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



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

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



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

$$= 4975\text{ m}$$

$$= 5.0\times10^3\text{ m}$$

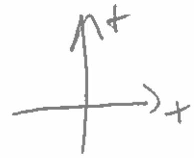
∴ Jogger's final displacement is 5.0×10^3 m W 15° N.

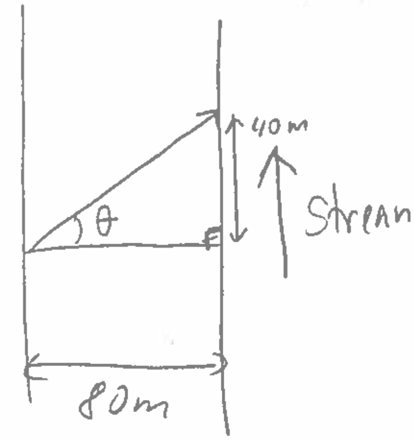
$$\theta = \tan^{-1}\left(\frac{1285}{4813}\right)$$

$$= 15°$$

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

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

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

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

$\doteq 1.8\ m/s$

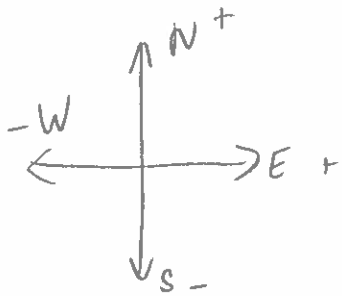
↑ magnitude

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

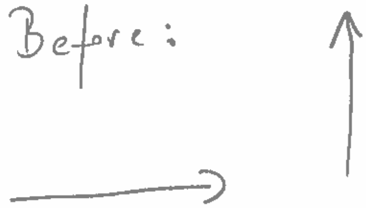
$\theta \doteq 27°$

↑ direction

3. A car enters an intersection at 20.0 m/s where is collides with a truck. Nobody gets hurt. However, the impact rotates the car by 90° and gives it a speed of 15 m/s. Determine the average acceleration of the car if it was in contact with the truck for 1.25 s.



Before:



$v_i = 20\ m/s\ [E]$

After

$\vec{v} = 15\ m/s\ [N]$

G: $\vec{v}_i = [20, 0]\ m/s$

$\vec{v}_f = [0, 15]\ m/s$

$\Delta t = 1.25\ s$

R: $\vec{a} = ?\ [m/s^2]$

A: $\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$

$= \frac{[0, 15] - [20, 0]}{1.25}$

$= \frac{[-20, 15]}{1.25}$

$= \frac{1}{1.25} \cdot [-20, 15]$

$= [-16, 12]\ m/s^2$

$\|\vec{a}\| = \sqrt{(-16)^2 + 12^2}$

$= \sqrt{400}$

$= 20\ m/s^2$

$\theta = \tan^{-1}\left(\frac{12}{16}\right)$

$\theta \doteq 37°$

S: The average acceleration is $20\ m/s^2$ [W 37° N].