Displacement and Velocity Problems

1. $\Delta\vec{d}_1 = 25\text{ km [E]}$, $\Delta t_1 = 20.0\text{ min} \times \frac{1\text{ h}}{60\text{ min}} = 0.333\text{ h}$

$\Delta\vec{d}_2 = 275\text{ km [E]}$ $\Delta t_2 = 2.50\text{ h}$

a) $\Delta\vec{d}_R = ?$ $\Delta d_T = ?$

$\Delta\vec{d}_R = \Delta\vec{d}_1 + \Delta\vec{d}_2$ E = +

$= 25\text{ km [E]} + 275\text{ km [E]}$

$= 3.00 \times 10^2\text{ km [E]}$

$\Delta d_T = \Delta d_1 + \Delta d_2$

$= 25\text{ km} + 275\text{ km}$

$= 3.00 \times 10^2\text{ km}$

b) $\Delta t_T = ?$ $\vec{v}_{av} = ?$

$\Delta t_T = \Delta t_1 + \Delta t_2$

$= 0.333\text{ h} + 2.50\text{ h}$

$= 2.83\text{ h}$

$\vec{v}_{av} = \frac{\Delta\vec{d}_R}{\Delta t_T} = \frac{3.00 \times 10^2\text{ km [E]}}{2.83\text{ h}}$

$= 106\text{ km/h [E]}$.

c) $v_{av} = ?$ $v_{av} = \frac{\Delta d_T}{\Delta t} = \frac{3.00 \times 10^2\text{ km}}{2.83\text{ h}}$

$= 106\text{ km/h}$

∴ the average velocity of the train was 106 km/h [E] and the average speed was 106 km/h.

2] $\Delta\vec{d}_1 = 3.0\text{ km [W]}$ $\Delta t_1 = 18\text{ min}$

$\Delta\vec{d}_2 = 1.8\text{ km [E]}$ $\Delta t_2 = 11\text{ min}$

a) $\Delta\vec{d}_R = ?$ $\Delta d_T = ?$

let W = +

$\Delta\vec{d}_R = \Delta\vec{d}_1 + \Delta\vec{d}_2$

$= 3.0\text{ km [W]} + 1.8\text{ km [E]}$

$= 3.0\text{ km} - 1.8\text{ km}$

$= 1.2\text{ km}$

$= 1.2\text{ km [W]}$

$\Delta d_T = \Delta d_1 + \Delta d_2$

$= 3.0\text{ km} + 1.8\text{ km}$

$= 4.8\text{ km}$

b) $\Delta t_T = ?$ $\vec{v}_{av} = ?$

$\Delta t_T = \Delta t_1 + \Delta t_2$

$= 18\text{ min} + 11\text{ min}$

$= 29\text{ min}$

$= 29\text{ min} \times \frac{1\text{ h}}{60\text{ min}}$

$= 0.483\text{ h}$ * keep at least one extra digit for further calculations

$\vec{v}_{av} = \frac{\Delta\vec{d}_R}{\Delta t_T} = \frac{1.2\text{ km [W]}}{0.483\text{ h}} = 2.483\text{ km/h [W]}$

∴ the average velocity was 2.5 km/h [W].

c) $v_{av} = ?$ $v_{av} = \frac{\Delta d_T}{\Delta t_T} = \frac{4.8\text{ km}}{0.483\text{ h}} = 9.9\text{ km/h}$

∴ the average speed was 9.9 km/h.

d) The magnitude of the average velocity was <u>less</u> than the magnitude of the average speed because the runners changed direction. This resulted in the magnitude of their displacement being <u>less</u> than the magnitude of their distance travelled.

3] a) $\Delta\vec{d}_1 = 1.2\text{km [N]}$ $\Delta t_1 = 12\text{min}$

$\Delta\vec{d}_2 = 2.5\text{km [S]}$ $\Delta t_2 = 30.\text{min}$ ← we'll + assume 2 sig digs here

$\Delta\vec{d}_3 = 1.8\text{km [N]}$ $\Delta t_3 = 15\text{min}$

a) $\Delta\vec{d}_R = ?$ Let N = +

$\Delta d_T = ?$

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

$= 1.2\text{km [N]} + 2.5\text{km [S]} + 1.8\text{km [N]}$

$= 1.2\text{km} - 2.5\text{km} + 1.8\text{km}$

$= 0.5\text{ km}$

$= 0.5\text{ km [N]}$

$\Delta d_T = \Delta d_1 + \Delta d_2 + \Delta d_3$

$= 1.2\text{km} + 2.5\text{km} + 1.8\text{km}$

$= 5.5\text{ km}$

b) $\Delta t_T = ?$

$\vec{v}_{av} = ?$

$\Delta t_T = \Delta t_1 + \Delta t_2 + \Delta t_3$

$= 12\text{min} + 30\text{min} + 15\text{min}$

$= 57\text{ min}$

$= 57\text{min} \times \frac{1\text{h}}{60\text{min}}$

$= 0.95\text{h}$

$\therefore \vec{v}_{av} = \frac{\Delta\vec{d}_R}{\Delta t_T} = \frac{0.5\text{km [N]}}{0.95\text{h}} = 0.5\text{ km/h [N]}$

c) $v_{av} = ?$ $v_{av} = \frac{\Delta d_T}{\Delta t_T} = \frac{5.5\text{km}}{0.95\text{h}} = 5.8\ \frac{\text{km}}{\text{h}}$

∴ her average velocity was 0.5 km/h [N] and her average speed was 5.8 km/h.

4] $\Delta\vec{d}_R = ?$

$\vec{v}_{av} = 8.5\text{m/s [F]}$

$\Delta t = 12\text{s}$

$\Delta\vec{d}_R = \vec{v}_{av} \cdot \Delta t$

$= (8.5\text{m/s [F]})(12\text{s})$

$= 102\text{ m [F]}$

$= 1.0 \times 10^2\text{ m [F]}$

∴ her resultant displacement was 1.0×10^2 m [F].

5] $\vec{v}_{av} = 50.0\text{km/h [W]}$

$\Delta\vec{d} = 275\text{ km [W]}$

$\Delta t = ?$

$\Delta t = \frac{\Delta\vec{d}}{\vec{v}_{av}}$

$= \frac{275\text{km [W]}}{50.0\text{km/h [W]}}$

$= 5.50\text{ h}$

∴ the car took 5.50 h to travel this displacement.

6] $\Delta\vec{d}_R = ?$

$\Delta d_T = 4.00 \times 10^2\text{ m}$

S/F

a) $\Delta\vec{d}_R = 0.0$ m

x as the runner ended up where he started.

b) $\Delta t = 60.\text{s}$ (* we'll assume 2 sig digs)

$v_{av} = ?$

$\vec{v}_{av} = ?$

$v_{av} = \frac{\Delta d_T}{\Delta t} = \frac{4.00 \times 10^2\text{m}}{60.\text{s}}$

$= 6.7\text{ m/s}$

$\vec{v}_{av} = \frac{\Delta\vec{d}_R}{\Delta t} = \frac{0.0\text{m}}{60.\text{s}} = 0.0\text{m/s}$

c) The average speed reflects the total distance travelled as the runner runs around the track. The average velocity is zero as the runner ended where he had started so that his