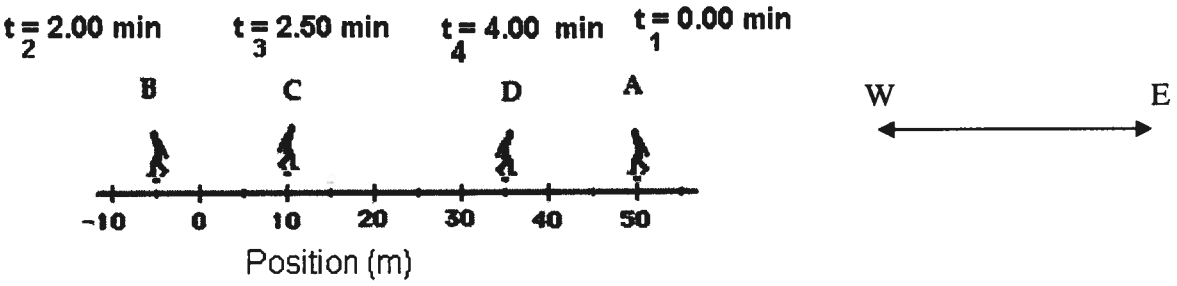
SPH3U0 **Position , Displacement and Velocity Practice**

Finding Displacement from a Change in Position: $\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$

1. A soccer coach is pacing along the sideline as her team plays a close game. She starts at position A at time zero. She walks to position B and then turns around walking to position C and arrives at position D at time 4.00 min.



a) State her position with respect to the 0 reference point (Home) at each location. Make sure to indicate the full position!

A: $\vec{d}_1$ = 50.0 m [East] of Home
B: $\vec{d}_2$ = 5.0 m [W] of home
C: $\vec{d}_3$ = 10.0 m [E] of home
D: $\vec{d}_4$ = 35.0 m [E] of home

b) Find her displacement when she walks from: let E = +

i. A to B: $\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$ = 5.0 m [W] − 50.0 m [E] = −5.0 − 50.0 m = −55.0 m = 55.0 m [W]

ii. B to C: $\Delta\vec{d} = \vec{d}_3 - \vec{d}_2$ = 10.0 m [E] − 5.0 m [W] = 10.0 − (−5.0) = 15.0 m [E]

iii. C to D: $\Delta\vec{d} = \vec{d}_4 - \vec{d}_3$ = 35.0 m [E] − 10.0 m [E] = 25.0 m [E]

iv. A to D: $\Delta\vec{d} = \vec{d}_4 - \vec{d}_1$ = 35.0 m [E] − 50.0 m [E] = −15.0 m [E] = 15.0 m [W]

c) If it takes her 4.00 minutes to walk from A to D, find her average velocity.

Δt = 4.00 min
$\Delta\vec{d}_R$ = 15.0 m [W]
$\vec{v}_{av}$ = ?

$\vec{v}_{av} = \frac{\Delta\vec{d}_R}{\Delta t} = \frac{15.0\text{ m [W]}}{4.00\text{ min}} = 3.75\text{ m/min [W]}$

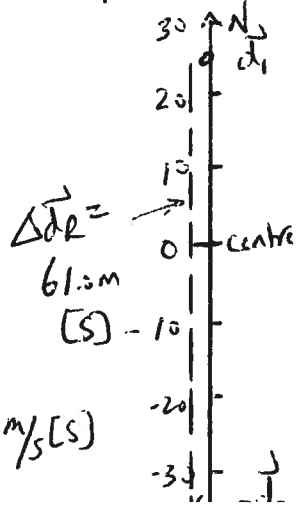
2. A hockey player starts 25.0 m North of centre line and skates to a position 36.0 m South of centre line in a time of 12.0 seconds.
   a) Draw a diagram representing the hockey's player motion and find the resultant displacement.
   b) Calculate the resultant displacement using the math method.
   c) Find the average velocity of the player's motion.

let N = +
$\Delta\vec{d}_R$ = ?
$\vec{d}_1$ = 25.0 m [N]
$\Delta\vec{d}_2$ = 36.0 m [S]

$\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$
= 36.0 m [S] − 25.0 m [N]
= −36.0 − 25.0
= −61.0
= 61.0 m [S]

b) Δt = 12.0 s
$\Delta\vec{d}$ = 61.0 m [S]
$\vec{v}_{av}$ = ?

$v_{av} = \frac{\Delta d}{\Delta t} = \frac{61.0\text{ m [S]}}{12.0\text{ s}} = 5.08\text{ m/s [S]}$



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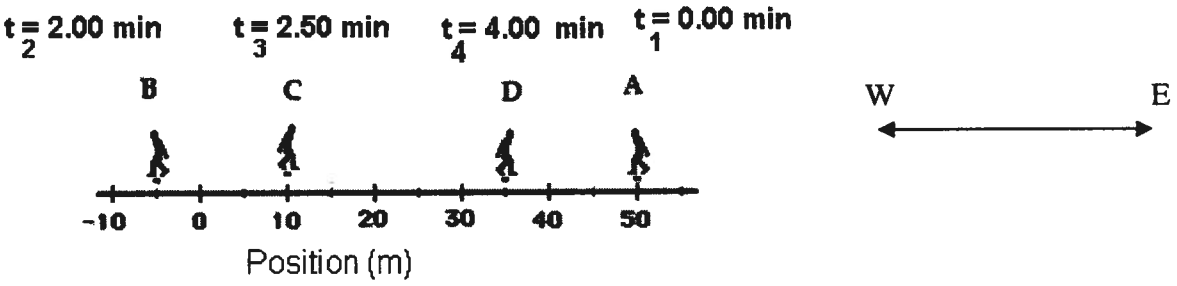

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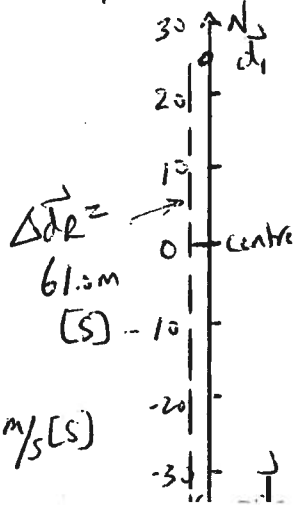
$\vec{d_2}$ = 36.0 m [S]

$\vec{\Delta d} = \vec{d_2} - \vec{d_1}$
= 36.0 m [S] − 25.0 m [N]
= −36.0 − 25.0
= −61.0
= 61.0 m [S]

b) Δt = 12.0 s
$\vec{\Delta d}$ = 61.0 m [S]
$\vec{v}_{av}$ = ?

$\vec{v}_{av} = \frac{\vec{\Delta d}}{\Delta t}$
$= \frac{61.0 \text{ m [S]}}{12.0 \text{ s}} = 5.08 \text{ m/s [S]}$



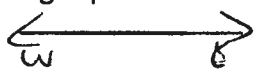
Finding ResultantDisplacement from a series of displacements: $\overrightarrow{\Delta d_R} = \overrightarrow{\Delta d_1} + \overrightarrow{\Delta d_2} + \overrightarrow{\Delta d_3}$

3. Two dedicated cross country runners are out for a training run. They first run 3.0 km west in a time of 18.0 minutes. They then turn around and run 1.8 km east in a time of 11.0 minutes when they stop to chat with friends coming from school.

a) Find their resultant displacement and total distance travelled.
b) Find their average velocity in km/h.
c) Find their average speed in km/h.
d) Discuss any differences you notice between the magnitude of their average velocity and their average speed.

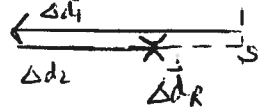
the magnitude of the speed is greater as they moved backwards during the run.

$\Delta \vec{d}_1 = 3.0\text{km(W)}$
$\Delta \vec{d}_2 = 1.8\text{km(E)}$
$\Delta t = 18.0\text{min} + 11.0\text{min} = 29.0\text{min}$
$\frac{29.0\text{min}}{60.0\text{min/h}} = 0.483\text{h}$



Scale: 1cm = 1km

let E = +



$\Delta \vec{d}_R = \Delta \vec{d}_1 + \Delta \vec{d}_2$
$= 3.0\text{km(W)} + 1.8\text{km(E)}$
$= -3.0\text{km} + 1.8\text{km}$
$= -1.2\text{km}$
$= 1.2\text{km(W)}$

$\vec{V}_{AV} = \frac{\Delta \vec{d}_R}{\Delta t} = \frac{1.2\text{km(W)}}{0.483\text{h}}$
$= 2.48\frac{\text{km}}{\text{h}}$ (W)

$V_{AV} = \frac{\Delta d_T}{\Delta t} = \frac{3.0\text{km} + 1.8\text{km}}{0.483\text{h}}$
$= 9.93\text{ km/h}$

4. A student is delivering newspapers on a paper route. She walks 1.2 km north from home in a time of 12.0 minutes and then turns around and walks 2.5 km south in a time of 30.0 minutes. Just as she is about to go home, she discovers she missed one delivery. She then walks 1.8 km north in a time of 15.0 minutes to deliver her last paper.

a) Find her resultant displacement and total distance travelled.
b) Find her average velocity. c) Find her average speed.

$\Delta \vec{d}_1 = 1.2\text{km(N)}$
$\Delta \vec{d}_2 = 2.5\text{km(S)}$
$\Delta \vec{d}_3 = 1.8\text{km(N)}$
$\Delta t = 12.0\text{min} + 30.0\text{min} + 15.0\text{min}$
$= 57.0\text{min}$

$\Delta \vec{d}_R = ?$
$\vec{V}_{AV} = ?$
$V_{AV} = ?$

let N = +

$\Delta \vec{d}_R = \Delta \vec{d}_1 + \Delta \vec{d}_2 + \Delta \vec{d}_3$
$= 1.2\text{km(N)} + 2.5\text{km(S)} + 1.8\text{km(N)}$
$= +1.2 - 2.5 + 1.8$
$= 0.5\text{ km [N]}$

$\Delta d_T = \Delta d_1 + \Delta d_2 + \Delta d_3$
$= 1.2 + 2.5 + 1.8 = 5.5\text{ km}$

$\vec{V}_{AV} = \frac{\Delta \vec{d}_R}{\Delta t} = \frac{0.5\text{km[N]}}{57.0\text{min}}$
$= \frac{0.5\text{ km (N)}}{0.95\text{h}}$
$= 1.05\text{ km/h [N]}$

$V_{AV} = \frac{\Delta d_T}{\Delta t} = \frac{5.5\text{km}}{0.95\text{h}}$
$= 5.8\text{ km/h}$

5. A track and field runner runs once around the LASS track in a time of 60.0 seconds. The total track length is 4.00×10^2 m.

a) Find the runner's resultant displacement and total distance travelled.
b) Find the runner's average velocity and speed.
c) Briefly explain your answers to part (b).

a) $\Delta \vec{d}_R = 0$

$\Delta d_T = 4.00 \times 10^2\text{m}$
$\Delta t = 60.0\text{s}$

$\vec{V}_{AV} = \frac{\Delta \vec{d}_R}{\Delta t} = \frac{0}{60.0\text{s}} = 0$

$V_{AV} = \frac{\Delta d}{\Delta t} = \frac{4.00 \times 10^2\text{m}}{60.0\text{s}} = 6.67\text{ m/s}$

c) The average velocity is zero as the displacement is zero. The runner stopped and started in the same location.

6. What is wrong with the following statement? "A man walked at an average velocity of 5.2m/s."

This statement is incorrect as it refers to velocity (a vector) but does not include direction.