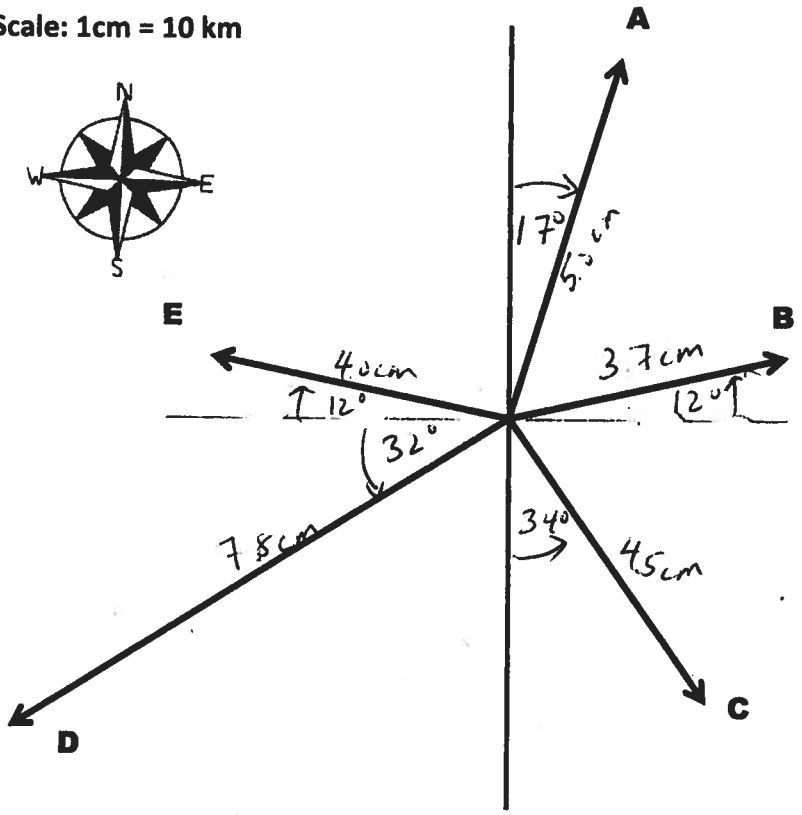
SPH3U0 **Analyzing Motion in 2-Dimensions: Displacement Vectors** Date:_____

1. Measure the length and angle of each of the following vectors. Find the magnitude and direction of each vector in the "real world" using the given scale. State TWO possible directions for each vector.

Scale: 1cm = 10 km



A= 50. Km [17° E of N] or [N 17° E]

B= 37 Km [12° N of E] or [E 12° N]

C= 45 Km [34° E of S] or [S 34° E]

D= 78 Km [32° S of W] or [W 32° S]

E= 40. Km [12° N of W] or [W 12° N]

Sample Questions: Scale Diagram Method

1) Newspaper carrier: A paper delivery person walks 1.5 km [East], then 2.0 km [North], then 3.0 km [West] and finally 3.0 km [North]. Use a scale diagram to determine their resultant displacement.

(Ans: 5.2 km [17 ° W of N])

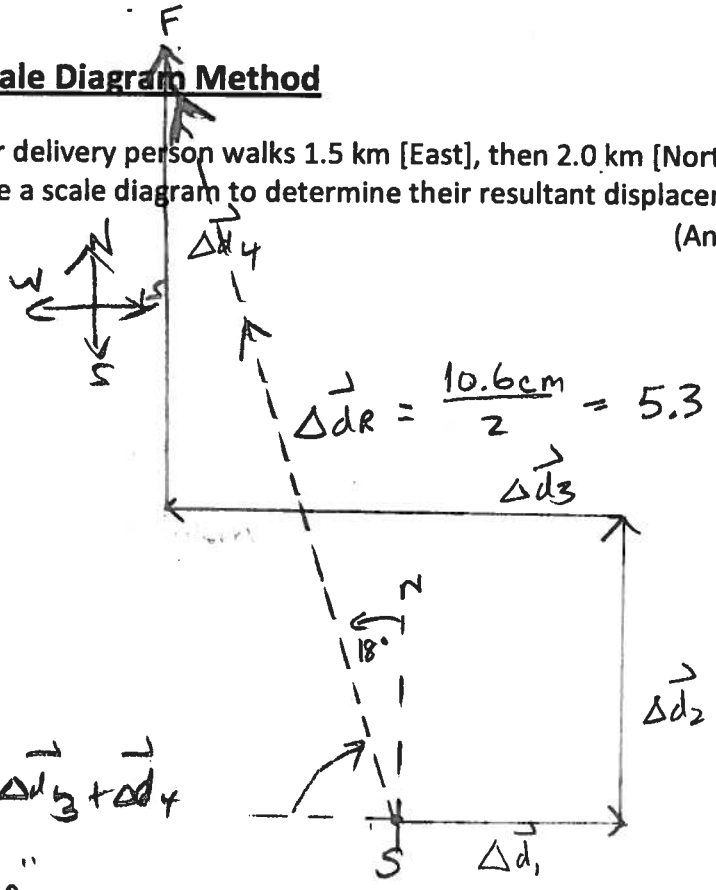
$\Delta\vec{d}_1$ = 1.5Km [E]

$\Delta\vec{d}_2$ = 2.0Km [N]

$\Delta\vec{d}_3$ = 3.0Km [W]

$\Delta\vec{d}_4$ = 3.0Km [N]

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



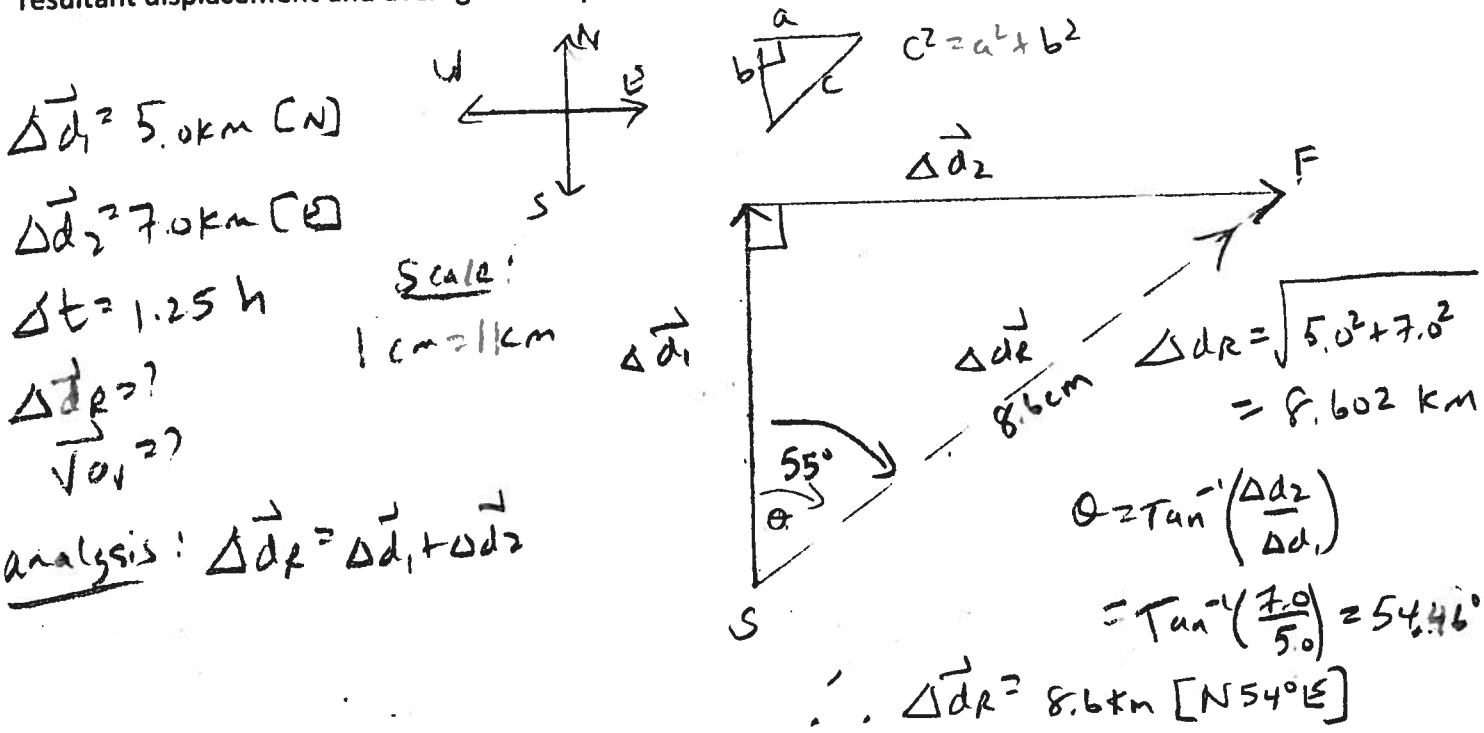
Analysis:

$\Delta\vec{d}_R = \Delta\vec{d}_1 + \Delta\vec{d}_2 + \Delta\vec{d}_3 + \Delta\vec{d}_4$

- add "Tail to tip"
- draw resultant from "Start to Finish"

Pythagorean Theorem/Trig Method or "Math" Method:

2) Runner: A runner runs 5.0 km [North] and then 7.0 km [East] in a time of 1.25 hours. What is their resultant displacement and average velocity? Ans: 8.6 km [54 ° E of N], 6.9 km/h [54° E of N]



SPH3U0 Homework: **Analyzing Displacement and Velocity in Two –Dimensions** Date:_____

1. A delivery van drives 15.0 km North, 17.0 km West, 30.0 km South and 25.0 km East to make four deliveries. The total trip took 2.00 hours. Find the van's resultant displacement and average velocity.

2. A forward on a soccer team makes the following moves as she follows the motion of the ball. She runs 8.5 m East, then runs 12.0 m South, and finally runs 13.5 m West before the ball is passed to her. If her entire motion took 7.0 seconds, find her resultant displacement and average velocity.

3. A fishing boat leaves port at 4:30 am in search of the day's catch. It travels 4.50 km [East], then 2.50 km [South] and finally 1.50 km [West] before discovering a large school of fish on the boat's SONAR at 6:30 am. Find the boat's average velocity and average speed.

4. A cyclist travels at an average velocity of 25.0 km/h [East] for 0.500 hours on a long country road. She then turns left onto a second road and travels north at an average speed of 20.0 km/h for 0.750 hours. Find her average velocity over the entire trip.

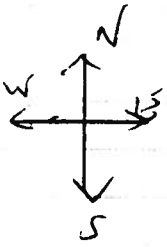
Answers:
1. 17.0 km [61.9° South of East], 8.50 km/h [61.9° South of East]
2. 13.0 m [22.6° West of South], 1.9 m/s [22.6° West of South]
3. 1.95 km/h [39.8 °S of E], 4.25 km/h
4. 15.6 km/h [50.2 °N of E]

Homework - Analyzing Displacement and Velocity in 2-Dimensions

1. $\Delta\vec{d}_1 = 15.0\,km\ [N]$
$\Delta\vec{d}_2 = 17.0\,km\ [W]$
$\Delta\vec{d}_3 = 30.0\,km\ [S]$
$\Delta\vec{d}_4 = 25.0\,km\ [E]$

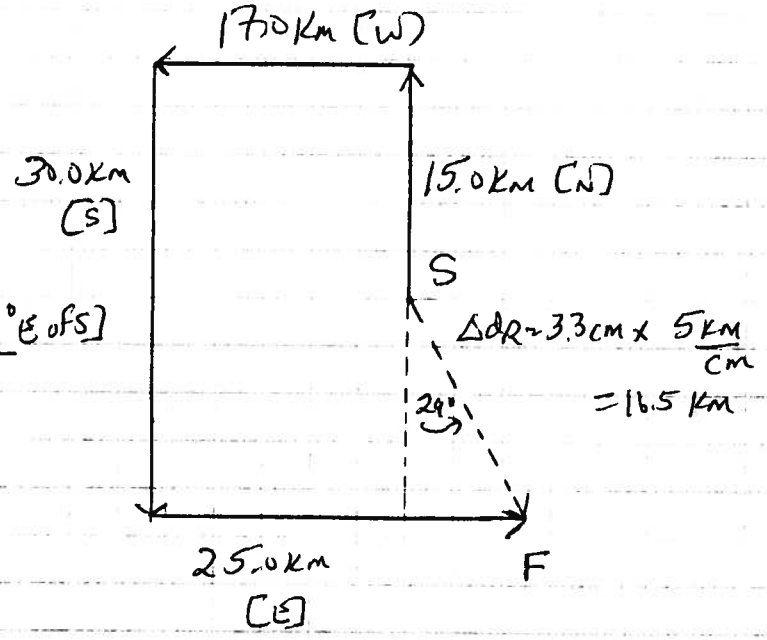
$\Delta t = 2.0\,h$

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

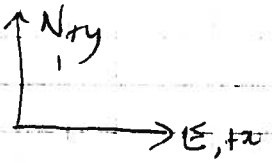


let $1\,cm = 5\,km$

Scale diagram:



$\therefore \Delta\vec{d}_R = 16.5\,km\ [29°\ E\ of\ S]$

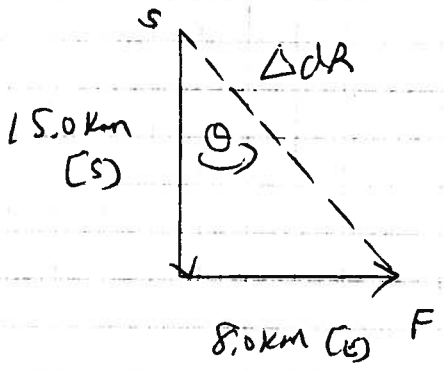


OR

Math Method:

$\Delta\vec{d}_y = 15.0\,km\ [N] + 30.0\,km\ [S]$
$= +15.0\,km - 30.0\,km$
$= -15.0\,km$
OR $15.0\,km\ [S]$

$\Delta d_x = 17.0\,km\ [W] + 25.0\,km\ [E]$
$= -17.0\,km + 25.0\,km$
$= 8.0\,km\ [E]$



$\Delta d_R = \sqrt{15.0^2 + 8.0^2} = 17.0\,km$

$\theta = \tan^{-1}\left(\frac{8.0}{15.0}\right) = 28.1°$

$\therefore \Delta\vec{d}_R = 17.0\,km\ [28.1°\ E\ of\ S]$

Averag velocity: $\vec{v}_{av} = \frac{\Delta \vec{d}_R}{\Delta t} = \frac{17.0\text{km}\ [28.1°\ E\ of\ S]}{2.00\text{h}}$

$= 8.50\ \text{km/h}\ [28.1°\ E\ of\ S]$

2] $\Delta \vec{d}_1 = 8.5\text{m}\ [E]$

$\Delta \vec{d}_2 = 12.0\text{m}\ [S]$

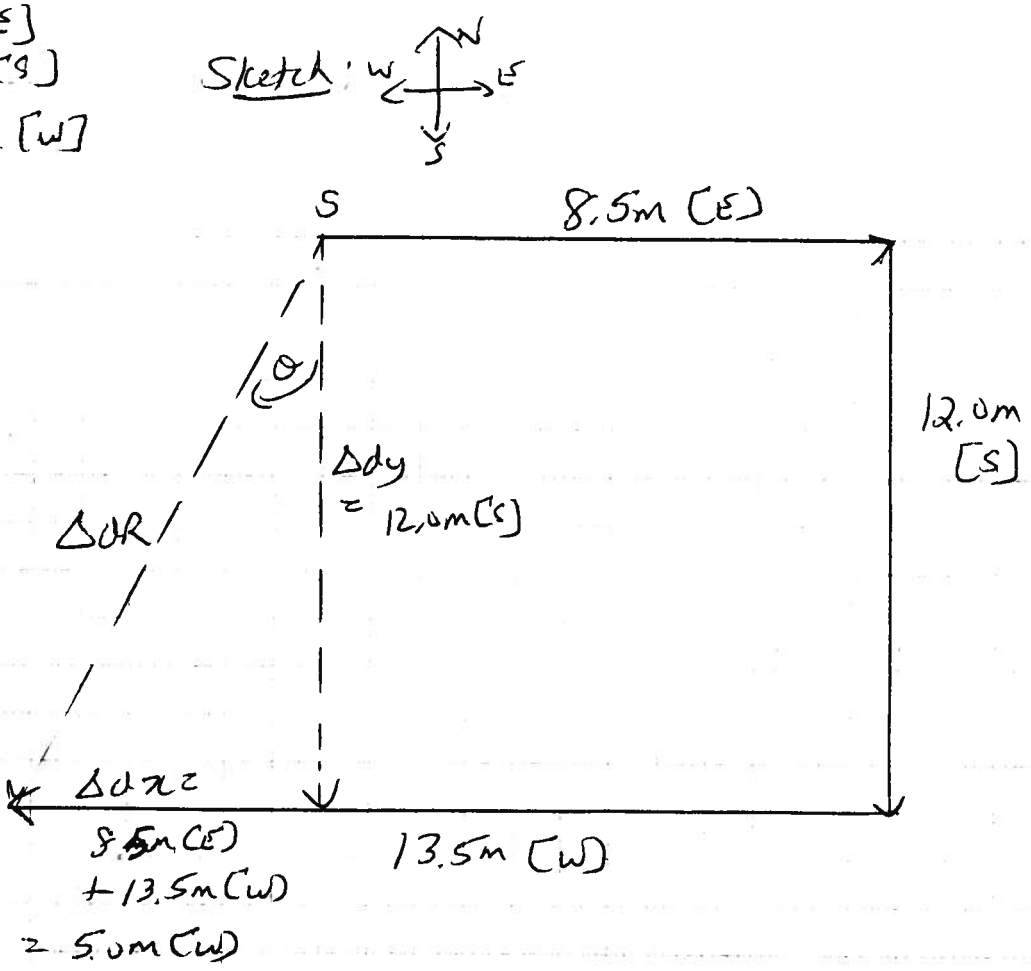
$\Delta \vec{d}_3 = 13.5\text{m}\ [W]$

$\Delta t = 7.0\text{s}$

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

$\Delta t = ?$

Sketch:



$\Delta \vec{d}_R = \sqrt{12.0\text{m}^2 + 5.0\text{m}^2} = 13.0\text{m}$ $\quad \theta = \text{Tan}^{-1}\left(\frac{5.0}{12.0}\right) = 22.6°$

$\therefore \Delta \vec{d}_R = 13.0\text{m}\ [22.6°\ W\ of\ S]$

$\vec{v}_{av} = \frac{\Delta \vec{d}_R}{\Delta t} = \frac{13.0\text{m}\ [22.6°\ W\ of\ S]}{7.0\text{s}} = 1.9\ \text{m/s}\ [22.6°\ W\ of\ S]$

3] $\Delta\vec{d}_1 = 4.50\,km\,[E]$

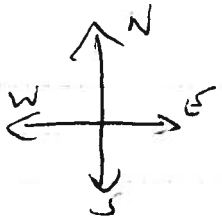
$\Delta\vec{d}_2 = 2.50\,km\,[S]$

$\Delta\vec{d}_3 = 1.50\,km\,[W]$

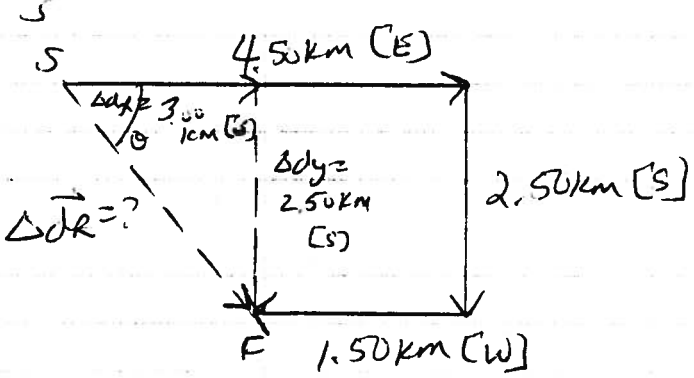
$\Delta t = 6:30am - 4:30am$

$= 2.00\,h$

$V_{av} = ?\quad \vec{V}_{av} = ?$



Sketch of motion:



$\Delta d_R = \sqrt{3.00\,km^2 + 2.50\,km^2}$ $\quad \theta = \tan^{-1}\left(\frac{2.50}{3.00}\right) =$

$= 3.905\,km$ $\quad \theta = 39.8°$ S of E

$\therefore \Delta\vec{d}_R = 391\,km\,[39.8°\ S\ of\ E]$

$\vec{V}_{av} = \frac{\Delta\vec{d}_R}{\Delta t} = \frac{3.91\,km\,[39.8°\ S\ of\ E)}{2.00\,h} = 1.95\,km/h\ [39.8°\ S\ of\ E]$.

Average speed:

Total distance, $\Delta d_T = 4.50\,km + 2.50\,km + 1.50\,km$

$= 8.50\,km$

$V_{av} = \frac{\Delta d_T}{\Delta t} = \frac{8.50\,km}{2.00\,h} = 4.25\,km/h$

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4] $\Delta\vec{d}_1 = ?$ $\vec{v}_1 = 25.0\ km/h\ [E]$, $\Delta t_1 = 0.500\ h$

$\rightarrow \Delta\vec{d}_1 = \vec{v}_1 \Delta t_1 = (25.0\ km/h\ [E])(0.500\ h) = 12.5\ km\ [E]$

$\Delta\vec{d}_2 = ?$ $\vec{v}_2 = 20.0\ km/h\ [N]$, $\Delta t_2 = 0.750\ h$

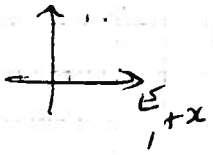
$\Delta\vec{d}_2 = \vec{v}_2 \cdot \Delta t_2 = (20.0\ km/h\ [N])(0.750\ h) = 15.0\ km\ [N]$

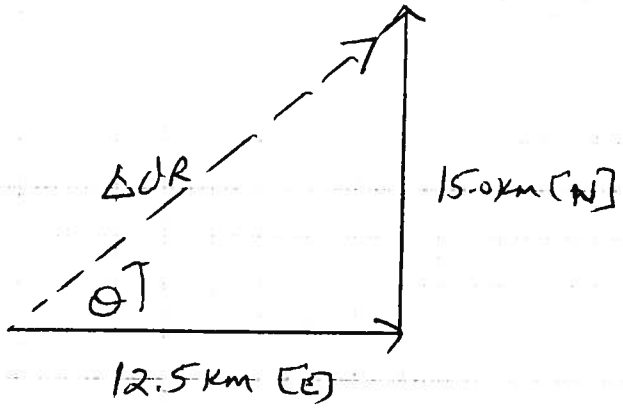
$\Delta\vec{d}_R = ?$

$\Delta t_T = 0.500\ h + 0.750\ h = 1.25\ h$

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

Sketch:





$|\Delta\vec{d}_R| = \sqrt{12.5^2 + 15.0^2}$

$= 19.5\ km$

$\theta = \tan^{-1}\left(\frac{15.0}{12.5}\right) = 50.2°$

$\therefore \Delta\vec{d}_R = 19.5\ km\ [50.2°\ N\ of\ E]$

$\vec{v}_{av} = \frac{\Delta\vec{d}_R}{\Delta t} = \frac{19.5\ km\ [50.2°\ N\ of\ E]}{1.25\ h}$

$= 15.6\ km/h\ [50.2°\ N\ of\ E]$