Vectors and Scalars

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A scalar quantity has a magnitude only.

A vector quantity has a magnitude and a direction.

* Vectors - Think of the theme park M+D's. *

Scalar quantities	Vector quantities
Speed	Velocity
distance	displacement
mass	Weight
time	force
energy	momentum
power	acceleration

Ex1

John runs 400m around an athletics track which is one lap.

Find:

Q) a) Distance travelled

b) Displacement

A) a) 400m

b) 0m (The start and finish point are the same)

Ex2

A 4kg bag of potatoes sit on a kitchen table.

Calculate or find:

Q a) Scalar quantity involved

b) Vector quantity involved

A a) mass = 4kg

b) Weight $\Rightarrow W = mg = 4 \times 9.8$

$W = 39.2N$

acting downwards

Ex3

A group of girls in the class do a sponsored walk. The course involves walking 6km due South followed by 2km due West.

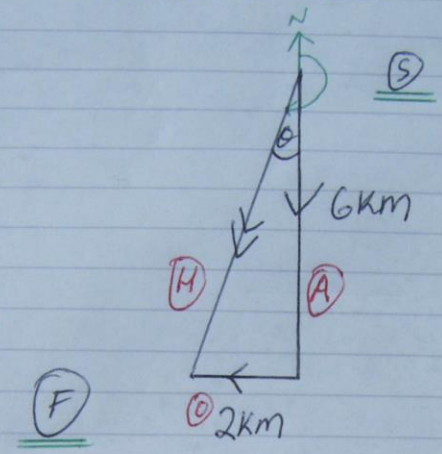
Calculate or find:

Q a) Distance travelled

b) Displacement

A a) distance travelled = 6+2 = 8Km

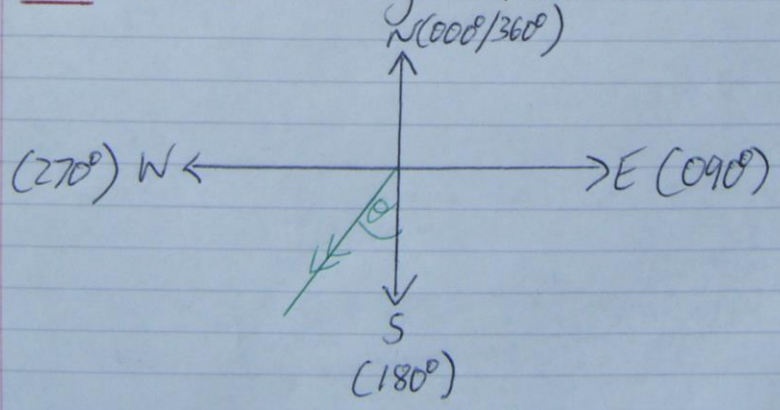
b) displacement ⇒ Vector ⇒ M+D's.



M ⇒ $SF^2 = 6^2 + 2^2 = 36 + 4 = 40$

⇒ $SF = \sqrt{40} = 6.32Km$

D ⇒ Bearing = $180^\circ + \theta^\circ$



SOH CAH TOA

$\tan\theta = \frac{O}{A} = \frac{2}{6} = \frac{1}{3} = 0.333$

$\theta = \tan^{-1}(0.333) = 18.4°$

For bearings $\theta = 18°$ ie whole number

Bearing $= 180° + 18° = 198°$

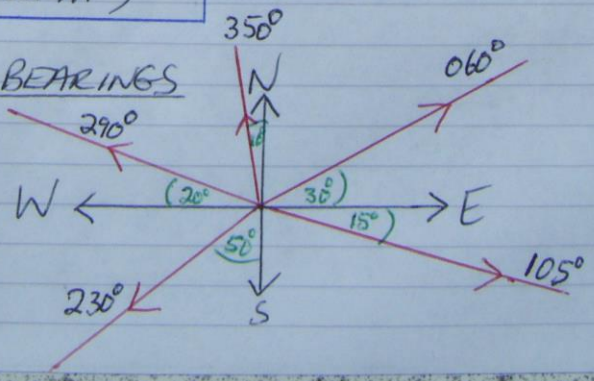
Displacement = M+D's = 6.32km @ 198°

Links

* Average speed = $\frac{\text{distance}}{\text{time}}$ → (m or km) / → (s or h)
  ↓ (ms^{-1} or kmh^{-1})

* Average velocity = $\frac{\text{displacement}}{\text{time}}$ → (m or km) / → (s or h)
  ↓ (ms^{-1} or kmh^{-1})

EXTRA BEARINGS

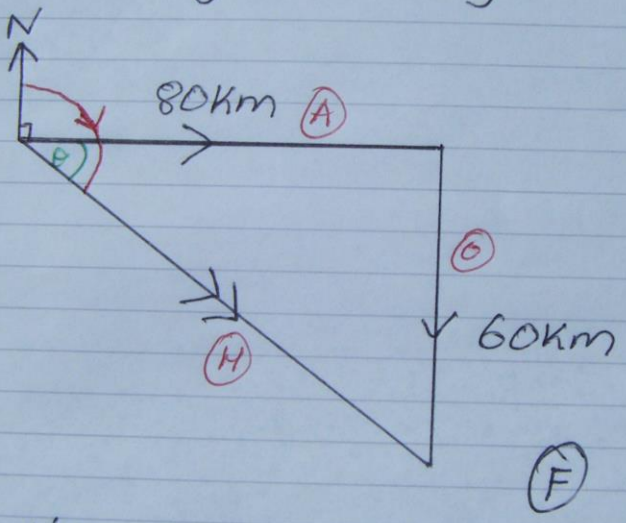


Ex4

Julie drives 80km due East followed by 60km due South in 2 hours.

Calculate or find:

a) distance travelled
b) Average speed
c) displacement
d) Average velocity



a) distance travelled $= 80 + 60 = \underline{140km}$

b) Average speed $= \frac{\text{distance}}{\text{time}} = \frac{140}{2} = \underline{70kmh^{-1}}$

c) Displacement $\Rightarrow$ Vector $\Rightarrow$ M + D's

M $SF^2 = 80^2 + 60^2 = 6400 + 3600 = 10{,}000$

$SF = \sqrt{10{,}000} = \underline{100km}$

$\underline{D}$ = Bearing = $090^\circ + \theta^\circ$

$\tan\theta = \frac{O}{A} = \frac{60}{80} = 0.75$

$\theta = \tan^{-1}(0.75) = 36.9^\circ$

for Bearings $\theta = 37^\circ$

Bearing = $090^\circ + 37^\circ = 127^\circ$

displacement = 100km @ 127° (M + D's)

d) Average velocity = $\frac{\text{displacement}}{\text{time}}$

$= \frac{100\text{km} @ 127^\circ}{2\text{h}}$

$= 50\text{kmh}^{-1} @ 127^\circ$ (M + D's)

Ex5

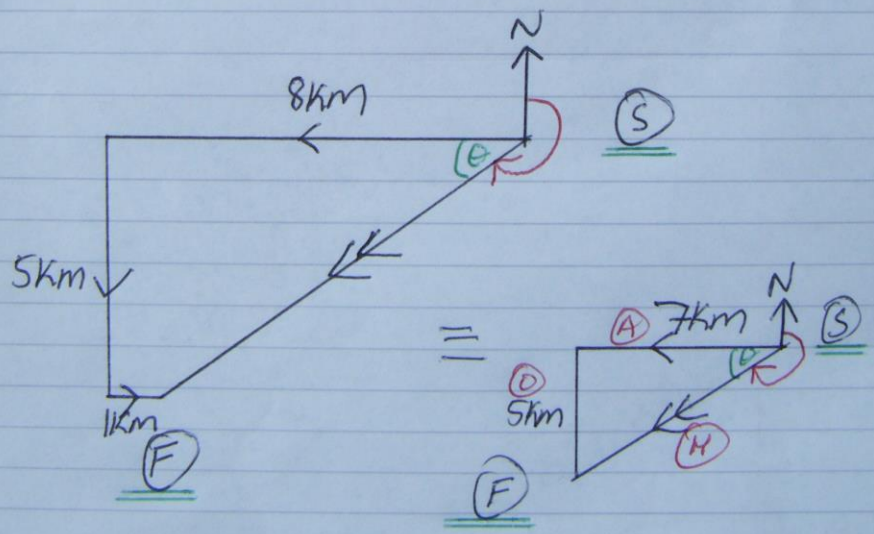
The boys in the Higher class go on an orienteering course to raise money for charity.

They walk 8km due West followed by 5km due South, followed by 1km due East in 4 hours.

Calculate or find:

Q a) distance travelled
b) Average speed
c) displacement
d) Average velocity

A



a) distance travelled $= 8+5+1 = \underline{14\text{km}}$

b) Average speed $= \frac{\text{distance}}{\text{time}} = \frac{14}{4} = \underline{3.5\,\text{kmh}^{-1}}$

c) displacement $\Rightarrow$ Vector $\Rightarrow$ M+D's

M $\quad SF^2 = 7^2+5^2 = 49+25 = 74$

$SF = \sqrt{74} = \underline{8.6\text{km}}$

D $\quad \text{Tan}\theta = \frac{O}{A} = \frac{5}{7} = 0.714$

$\theta = \text{Tan}^{-1}(0.714) = 35.5^\circ$

For Bearings $\theta = 36^\circ$

Bearing $= 270^\circ - \theta^\circ = 270^\circ - 36^\circ$

$= \underline{234^\circ}$

displacement $= \underline{8.6\text{km}\ @\ 234^\circ}$ (M + D's)

d) Average velocity $= \frac{\text{displacement}}{\text{time}} = \frac{8.6\text{km}@234^\circ}{4\text{h}}$

Average velocity $= \underline{2.15\,\text{kmh}^{-1}\ @\ 234^\circ}$ (M + D's)

Ex6

A group of students walk the following course:

- 2·3km @ 320° followed by
- 3·1km @ 250° followed by
- 1·5km @ 150° in 150 minutes.

Calculate or find:

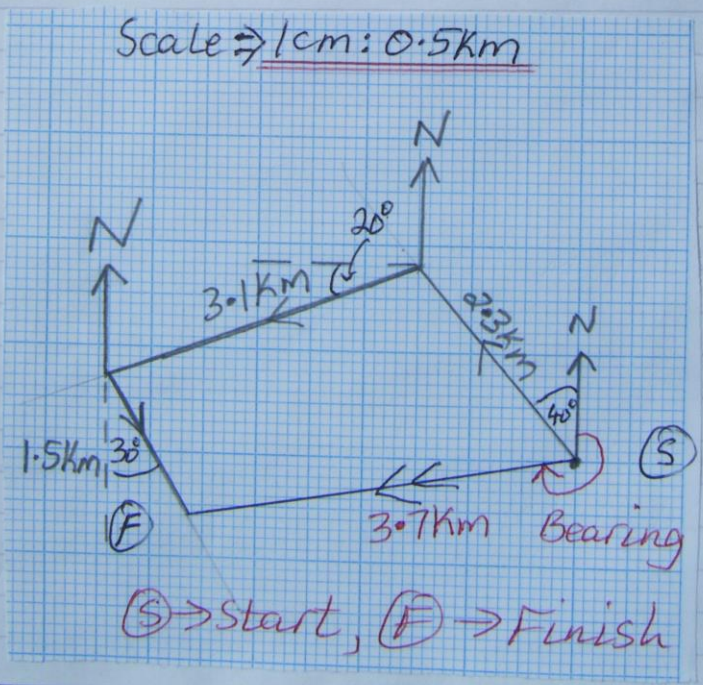
Q a) distance travelled

b) Displacement

c) Average speed

d) Average velocity.

A



(10)

a) distance travelled = 2·3 + 3·1 + 1·5
= 6·9 Km

b) From Scale diagram.

displacement ⇒ Vector ⇒ M + D's
M + D's
= 3·7 Km @ 261°

c) Average speed = distance / time = 6·9 / 2·5 = 2·76 Kmh⁻¹

d) Average velocity = displacement / time = 3·7 Km @ 261° / 2·5
M + D's
= 1·48 Kmh⁻¹ @ 261°

EX7 - 2007 HIGHER PAPER Q21 (11)

Q

Competitors are racing remote control cars. The cars have to be driven over a precise route between checkpoints.

Each car is to travel from checkpoint A to checkpoint B by following these instructions.

"Drive 150 m due North, then drive 250 m on a bearing of 60° East of North (060)."

Car X takes 1 minute 6 seconds to follow these instructions exactly.

(a) By scale drawing or otherwise, find the displacement of checkpoint B from checkpoint A. 2

(b) Calculate the average velocity of car X from checkpoint A to checkpoint B. 2

(c) Car Y leaves A at the same time as car X.
Car Y follows exactly the same route at an average speed of 6·5 m s^{-1}.
Which car arrives first at checkpoint B?
Justify your answer with a calculation. 2

(d) State the displacement of checkpoint A from checkpoint B. 1
(7)

A

a) displacement ⇒ M+D's ⇒ 350m @ 038°

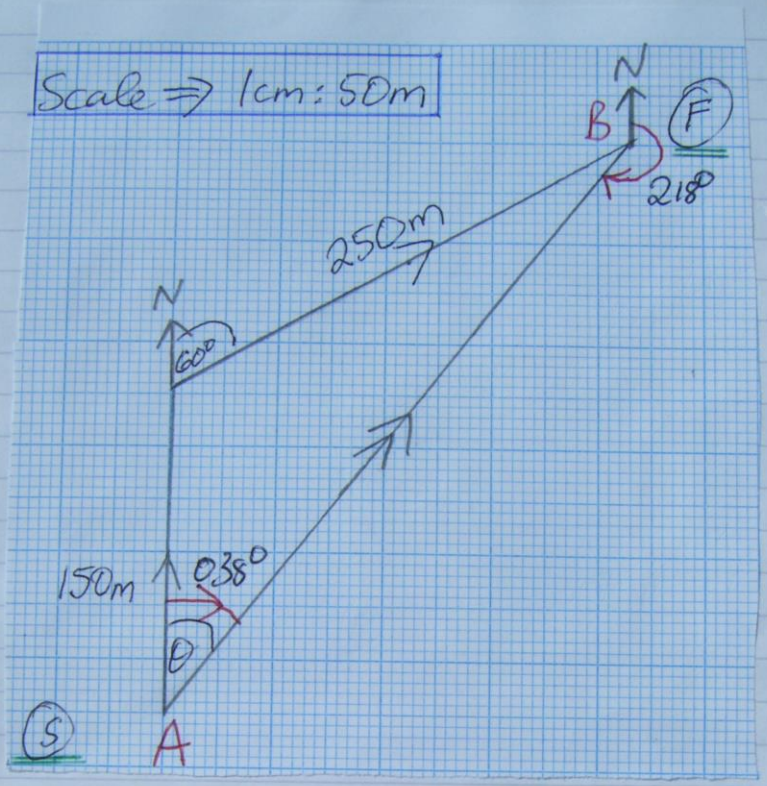
Tolerance = ±10m and ±2°

b) Average velocity = $\frac{\text{displacement}}{\text{time}} = \frac{350\text{m}@038^\circ}{66}$

M + D's

Average velocity = 5·3 ms^{-1} @ 038°

(12)



c) Average speed $= \frac{\text{distance}}{\text{time}} \Rightarrow 6.5 = \frac{400}{t}$

$\Rightarrow t = \frac{400}{6.5} = \underline{61.5s}$.

Car X → 66s
Car Y → 61.5s

Car Y arrives 4.5s earlier.

d) Displacement from B to A

⇒ Magnitude is the same = 350m
Direction from Bearing = 218°