Paragraph for Question no. 10 to 12

A boy lost in a jungle finds a note. In the note was written the following things.

Displacements

1. 300 m 53° South of East.
2. 400 m 37° North of East
3. 500 m North
4. 500 √2 m North-West
5. 500 m South

He starts walking at speed 2 m/s following these displacements in the given order.

10. How far and in which direction is he from the starting point after 5 min. and 50 s?

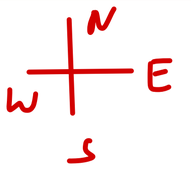
(A) 500 m due East
(B) 500 m due West
(C) 700 m due South-West
(D) 700 m due North-East

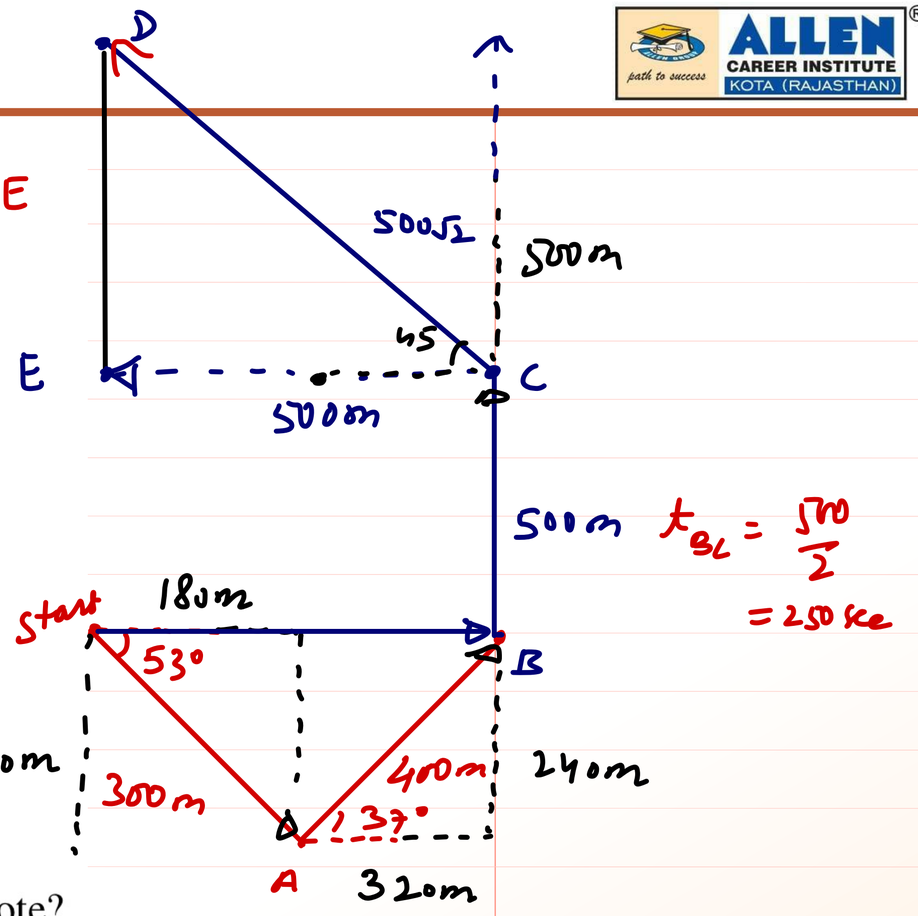
11. How far and in which direction is he from the starting point after 10 minutes?

(A) 500 √2 m due North
(B) 1200 m due North-East
(C) 500√2 m due North-East
(D) 900 m due 37° North of East

12. How far and in which direction has finally displaced after all the displacements in the note?

(A) 500√2 m due North-East
(B) 500 m due North
(C) 866 m due North-West
(D) 500√3 m due 60° North of West





(10) $t = 5\text{min} + 50\text{sec} = 350\text{sec}$

$s_{SB} = 500\text{ m East}$

$t_{SA} = \frac{300}{2} = 150\text{ sec}$

$t_{AB} = 400/2 = 200\text{ sec}$

At B

(11) $t = 10\text{min} = 600\text{ sec}$

He is at point C

Paragraph for Question no. 13 to 15

A boy A starts from a point P runs some distance towards east then turns 53° towards north and runs 75 m further to reach point Q. The boy maintains constant speed of 5 m/s in running from P to Q. Another boy B starts 2 s after A from point P and runs 100 m in a direction 37° north of east with a constant speed. Both of them meet at point Q.

13. How far in the east direction, has the boy A ran?

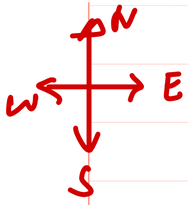
(A) 25 m (B) 30 m (C) 35 m (D) 40 m

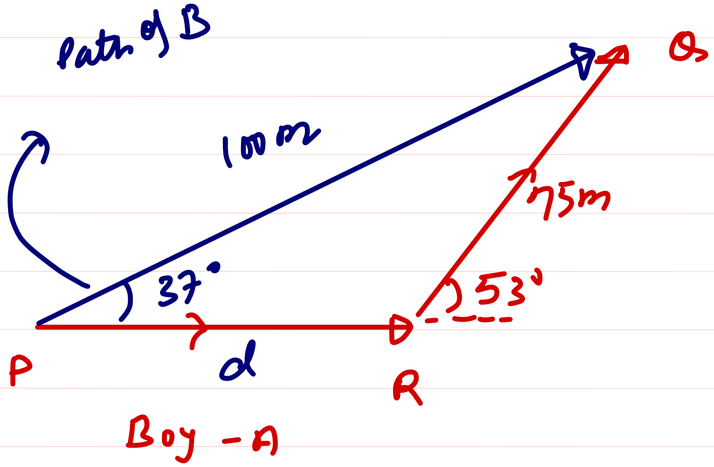
14. How long the boy A has to run to reach point Q.

(A) 20 s (B) 22 s (C) 24 s (D) 25 s

15. Magnitude of average velocity of the boy A is closest to

(A) 5 m/s (B) 4.45 m/s (C) 4.54 m/s (D) 3.75 m/s





(13)

$\tan 37 = \frac{75 \sin 53}{d + 75 \cos 53}$

$\frac{3}{4} = \frac{75 \times 4/5}{d + 75 \times 3/5} = \frac{15 \times 4}{d + 15 \times 3}$

$3d + 15 \times 9 = 15 \times 16$

$3d = 15 \times 7$

$d = 5 \times 7$

$\boxed{d = 35\text{m}}$ Ans

(14)

$t = \frac{d + 75}{5} = \frac{110}{5} = 22\text{s}$

Ans

(15)

Avg velocity $= \frac{\text{disp}}{\text{time}}$

$|\vec{v}_{avg}| = \frac{100}{22}$

$= 4.54\ \text{m/s}$

Ans

NOTE: "Avg of constant is always equal to that constant"

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Average

Avg speed

$$= \frac{\text{total distance}}{\text{time taken}}$$

$$v_{av} = \frac{d_{total}}{\Delta t}$$

Avg velocity

$$= \frac{\text{Net disp}}{\text{time taken}}$$

$$\vec{v}_{av} = \frac{\vec{s}}{\Delta t} = \frac{\vec{r}_f - \vec{r}_i}{\Delta t}$$

Avg Acceleration

$$= \frac{\text{change in velocity}}{\text{time taken}}$$

$$\vec{a}_{avg} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

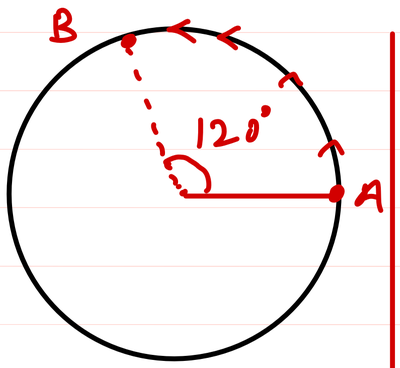
If function is given

$$v_{av} = \frac{\int v\,dt}{\int dt}$$

$$\vec{v}_{av} = \frac{\int \vec{v}\,dt}{\int dt}$$

$$\vec{a}_{av} = \frac{\int \vec{a}\,dt}{\int dt}$$

Ex A particle moves on a circle of radius (R) with uniform (constant) speed (v) as shown in figure



$t_{AB} = \frac{d_{AB}}{v}$

Find (i) $d_{AB} = ??$

(ii) $|\vec{S}_{AB}| = ??$

Avg speed (iii) $v_{av} = ??$

Avg velocity (iv) $|\vec{v}_{avg}| = ??$

(v) $|\vec{a}_{avg}| = ??$

(i) $d_{AB} = R\theta$

$= R\left(120° \times \frac{\pi}{180}\right)$

$\boxed{d_{AB} = \frac{2\pi R}{3}}$ Ans

(ii) $S = 2R \sin(\theta/2)$

$\boxed{S = 2R\frac{\sqrt{3}}{2} = \sqrt{3}R}$

(iii) Avg speed $= \frac{d_{AB}}{t_{AB}}$

$v_{av} = \frac{d_{AB}}{d_{AB}} \cdot v$

$\boxed{v_{av} = v}$ Ans

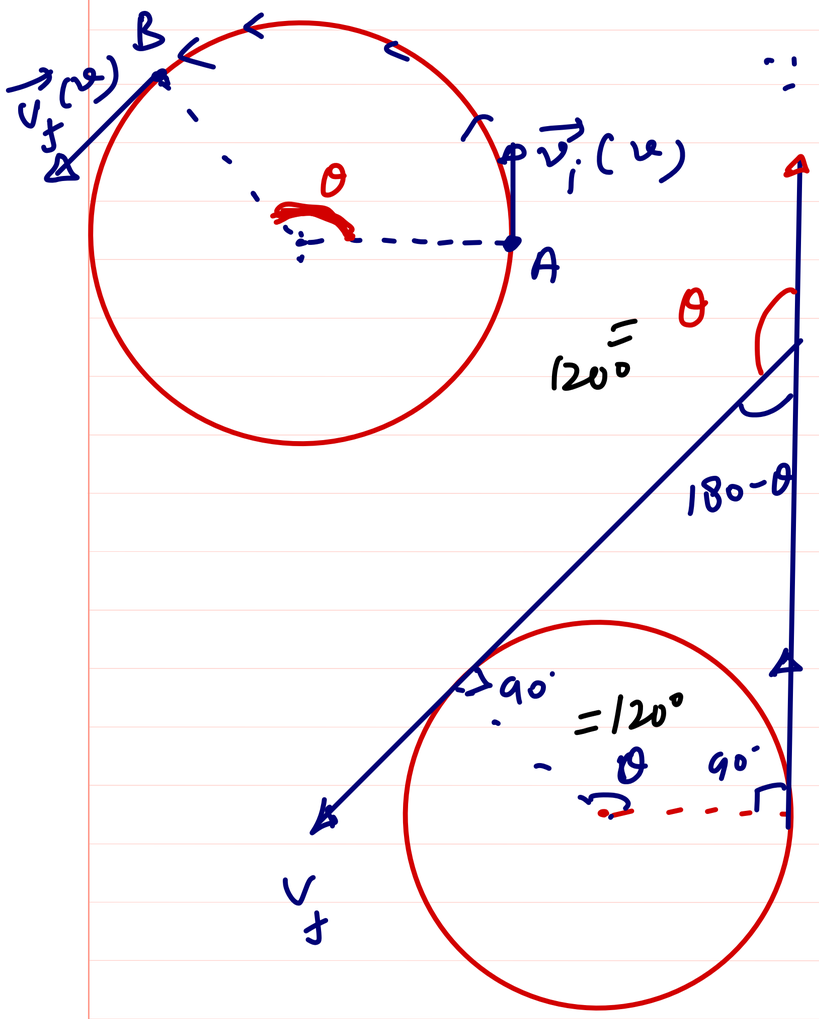
(iv) $|\vec{v}_{avg}| = \frac{|\vec{S}|}{t} = \frac{\sqrt{3}R}{d_{AB}} \times v$

$|\vec{v}_{avg}| = \frac{\sqrt{3}R \times v}{2\pi R} \times 3$

$\boxed{|\vec{v}_{avg}| = \frac{3\sqrt{3}v}{2\pi}}$ Ans

(v) $|\vec{a}_{avg}| = \frac{|\vec{v}_f - \vec{v}_i|}{t_{AB}} = \frac{2v \sin\theta/2}{2\pi R/3v}$

$|\vec{a}_{avg}| = \frac{3v^2}{\pi R} \sin(\theta/2)$



$$\because \vec{a}_{avg} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

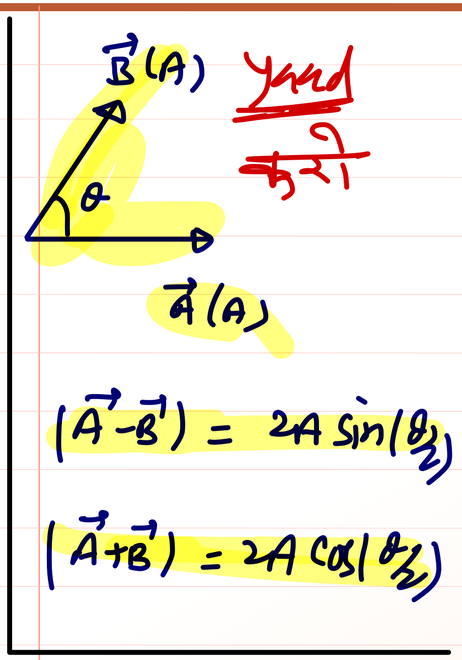
$$|\vec{a}_{avg}| = \frac{|\vec{v}_f - \vec{v}_i|}{\Delta t} = \frac{2v\sin(\theta/2)}{\Delta t}$$

$$|\vec{a}_{avg}| = \frac{2v\sin 60}{\frac{2\pi R}{3v}}$$

$$= \frac{3v^2}{\pi R} \times \frac{\sqrt{3}}{2}$$

$$\boxed{|\vec{a}_{avg.}| = \frac{3\sqrt{3}v^2}{2\pi R}}$$

Ans



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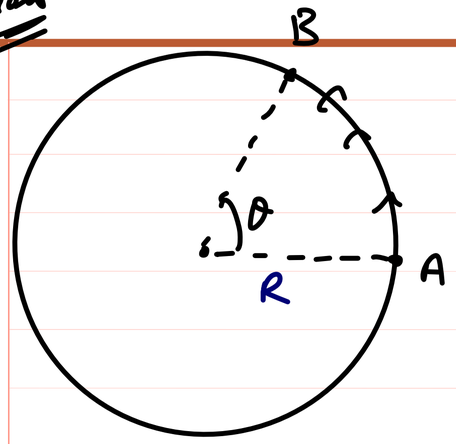
$|\vec{A}-\vec{B}| = 2A\sin(\theta/2)$

$|\vec{A}+\vec{B}| = 2A\cos(\theta/2)$

Intro



$t_{AB} = \frac{R\theta}{v}$

Uniform speed (v)

① $d_{AB} = R\theta$ → distance

② $|s_{AB}| = 2R\sin(\theta/2)$ → displacement

③ $v_{avg} = v$ → Avg speed

④ $|\vec{v}_{avg}| = \frac{2R\sin(\theta/2)}{R\theta/v}$

$|\vec{v}_{avg}| = \frac{2v}{\theta}\sin(\theta/2)$ → Avg velocity

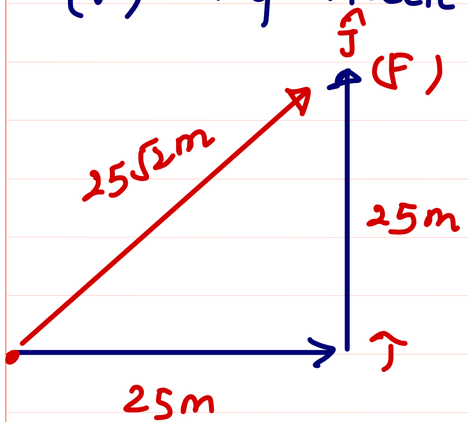
⑤ $|\vec{a}_{avg}| = \frac{2v\sin(\theta/2)}{R\theta/v}$

$a_{avg} = \frac{2v^2}{R\theta}\sin(\theta/2)$ → Avg acceleration

$\vec{v_i} = 5\hat{i}$, $\vec{v_f} = 5\hat{j}$

Ex = A particle moves with 5 m/s along East dirn for 5 sec then take a turn towards North and moves with same speed for same time. Find

(I) distance
(ii) displacement
(iii) Avg speed
(iv) Avg velocity
(V) Avg Accele.



(i) $d = 50$ m

(ii) $\vec{s} = 25\hat{i} + 25\hat{j}$

$s = 25\sqrt{2}$ m

(iii) $v_{avg} = \frac{50}{10} = 5$ m/s

(iv) $\vec{v}_{avg} = \frac{\vec{s}}{t} = \frac{25\hat{i} + 25\hat{j}}{10}$

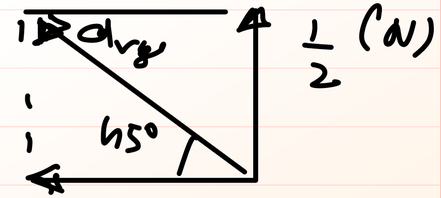
$|\vec{v}_{avg}| = 2.5\sqrt{2}$ m/s

(V) $\vec{a}_{avg} = \frac{\vec{v_f} - \vec{v_i}}{\Delta t} = \frac{5\hat{j} - 5\hat{i}}{10}$

$|\vec{a}_{avg}| = \frac{1}{\sqrt{2}}$ m/s^2

$= \frac{1}{\sqrt{2}}$, 45° due North of West

$\vec{a}_{avg} = -\frac{1}{2}\hat{i} + \frac{1}{2}\hat{j}$



Ex-1 A body moves in straight line with velocity v_1 for $1/3^{rd}$ time and for remaining time with v_2. Find average velocity.

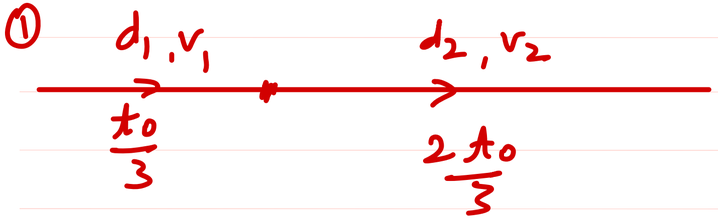
(a) $\frac{v_1}{3}+\frac{2v_2}{3}$ (b) $\frac{v_1}{3}+\frac{v_2}{3}$

(c) $\frac{2v_1}{3}+\frac{v_2}{3}$ (d) $v_1+\frac{2v_2}{3}$

Ex-2 A particle moves in straight line with velocity v_1 and v_2 for time intervals which are in ratio 1:2. Find average velocity.

(a) $\frac{v_1}{3}+\frac{2v_2}{3}$ (b) $\frac{v_1}{3}+\frac{v_2}{3}$

(c) $\frac{2v_1}{3}+\frac{v_2}{3}$ (d) $v_1+\frac{2v_2}{3}$

① 

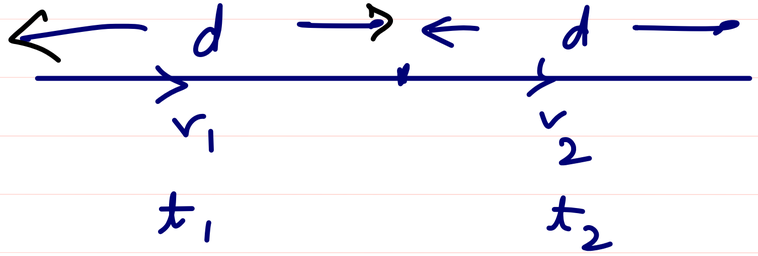
let time t_0

$$v_{avg} = \frac{d_1+d_2}{t_0} = \frac{v_1\frac{t_0}{3}+v_2\frac{2t_0}{3}}{t_0}$$

$$\boxed{v_{avg} = \frac{v_1}{3}+\frac{2v_2}{3}}$$ Ans =

② Same as ①

Ex A particle moves in a straight line cover half distance with speed v_1 and Remaining half with speed v_2 find Avg speed.



$$t_1 = \frac{d}{v_1}$$

$$t_2 = \frac{d}{v_2}$$

$$v_{avg} = \frac{2d}{t_1 + t_2}$$

$$= \frac{2d}{d/v_1 + d/v_2}$$

$$\boxed{v_{avg} = \frac{2v_1 v_2}{v_1 + v_2}}$$

Ans