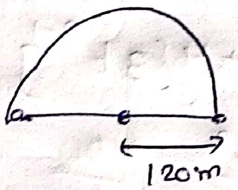
8th class WS-3: {Distance, Displacement
Task Average speed and Average velocity}

① Given The cyclist is revolving in a circular path of radius $r = 120$

Time taken for half rotation = 1 min = 60 sec.

$\therefore$ Total displacement = $2r \Rightarrow 2 \times 120$

$\Rightarrow 240$ m



$\therefore$ Average velocity = $\frac{\text{Total displacement}}{\text{Total time}}$

$= \frac{240}{60}\ \frac{\text{m}}{\text{sec}} = 4\ \text{m sec}^{-1}$

② Given that a motorist driven for north with a speed 85 kmph for 35 min. (i.e) $\frac{35}{60}$ hr =

So his displacement = speed × time

$= 85 \times \frac{35}{60}$ km

$= 85 \times \frac{35}{60} \times 12 = 85 \times \frac{7}{12}$

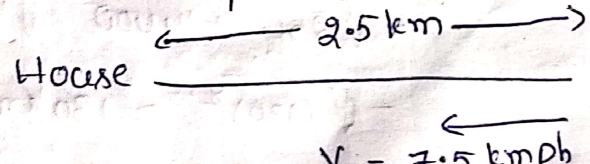
$= 49.56$ km

He then continues his journey towards north and covered 130 km in next 2 hrs.

So Total displacement = $49.56 + 130$

$\Rightarrow 179.56 \simeq 179.6$ km

③



For completing his journey time taken is 50 min = $\frac{50}{60} = \frac{5}{6}$ hrs

Here Total distance covered = 5 km

I^st half of the distance with a speed V_1 [House-market] and remaining half of the distance with a speed V_2 [Market-house]

$\therefore$ Average speed = $\frac{2V_1V_2}{} = \frac{2 \times 5 \times 7.5}{} = \frac{75}{12.5} = \frac{750}{125} = 6$ kmph

$\Rightarrow 6\ \text{kmph} = 6 \times \frac{5}{18} = \frac{5}{3}\ \text{m/s}$

(4) Given Relation $x = 3 - 3t + 4t^3$ which gives position

(A) of a Particle with respect to time

Now Average velocity - $\int x\,dt$ $\frac{dx}{dt}$

We know that $\frac{d}{dx}(\text{constant}) = 0$

$\frac{d}{dx} x^n = n x^{n-1}$

$= \frac{d}{dt}[3 - 3t + 4t^3]$

$\Rightarrow \frac{d}{dt}(3) - 3\frac{dt}{dt} + 4\frac{d}{dt}t^3$

$\Rightarrow 0 - 3(1) + 4[3t^{3-1}]$

$\Rightarrow 0 - 3 + 12t^2$

At $t = 3\text{sec}$ $\quad v = -3 + 12(3)^2 = -3 + 108$

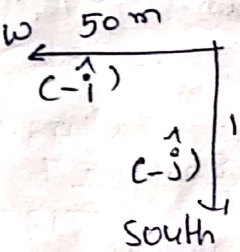
$= 105\ \text{cm/s}$

(5) Given Praneel travels 50m west and 120m south

(A) $\therefore$ Distance travelled = Total path length covered

$= 50 + 120 = 170\text{m}$

(i.e)



whenever directions are given we have to take vector form for measuring displacement

$\Rightarrow$ Displacement $= 50(-\hat{i}) + 120(-\hat{j})$

$\Rightarrow -50\hat{i} - 120\hat{j}$

$\therefore |\text{Displacement}| = \sqrt{(-50)^2 + (-120)^2}$

$= \sqrt{2500 + 14400} = \sqrt{16900}$

$= \sqrt{(130)^2} = 130\ \text{m}$

(6) (C) In $t_1 = 4\text{sec} \rightarrow$ Distance travelled $d_1 = 16\text{m}$

$t_2 = 2\text{sec} \rightarrow$ Distance travelled $d_2 = 16\text{m}$

$\therefore \langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{d_1 + d_2}{t_1 + t_2} = \frac{16 + 16}{4 + 2}$

$= \frac{32}{6} = 6.33\ \text{m/s}$

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⑦ Given length of the pool = 90m

For covering 180m, Usha takes 1 min = 60 sec

she is coming back to her initial position after 1 min [According to data given in question]

So her Total displacement = 0

$\therefore$ <velocity> = $\frac{\text{Total displacement}}{\text{Total time}} = \frac{0}{60} = 0$

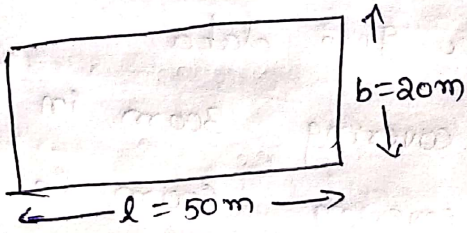
⑧ C

Total distance she braved swimmed = 180m

<speed> = $\frac{\text{Total distance}}{\text{Total time}} = \frac{180\text{m}}{60\text{sec}} = 3\ \text{m/s}$

⑨ Given

A



Rotation

For one round around the track Distance covered

= Circumference

= 2(l+b) = 2(50+20)

= 140m

For 2 rounds Total distance = 2 × 140m

= 280m.

Total time taken = 100 sec.

$\therefore$ <speed> = $\frac{\text{Total distance}}{\text{Total time}} = \frac{280}{100} = 2.8\ \text{m/s}$

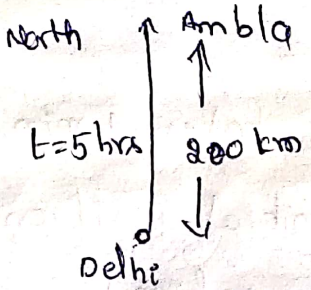
⑩ For After 2 turns around rectangular track the runner back to his starting point from where he started (i.e) initial and final positions are same.

$\therefore$ Total displacement = Final position − initial position

= 0

$\therefore$ <velocity> = $\frac{\text{Total displacement}}{\text{Total time}} = \frac{0}{100} = 0$

(11)



(d) As the car returns to delhi

Then the Displacement = 0

Because initial and final positions are same [Delhi]

So $\langle velocity \rangle = \frac{\text{Total displacement}}{\text{Total time}} = \frac{0}{10} = 0$

Here Total distance covered by the car = 200 + 200

For complete journey = 400 km

Total time taken = 5 hr + 5 hr = 10 hrs

$\langle speed \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{400}{10} = 40$ kmp

(12) (4)

A According to given data

Nithin covering 300 m in 15 sec where as

Jathin covering 600 m in 1 min → 60 sec.

So in ~~case~~ Nithin speed = $\frac{300}{15} = 20$ m/s

Jathin speed = $\frac{600}{60} = 10$ m/s

~~One~~ clearly Nithin will win the race because his speed is more than Jathin.

(13) (5)

(a) Given Athelet speed = 10 m/s

bicycle speed = 20 m/min = $\frac{20\text{ m}}{60\text{ sec}} = \frac{1}{3}$ m/s = 0.33

Scooter speed = 30 kmph = $30 \times \frac{5}{18} = \frac{25}{3} = 8.33$ m/

~~Ans~~ $a > c > b$

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(2)

(16) A Given For one revolution time taken = 4 sec.

(i) Along AB (half of rot) Distance covered = $\frac{1}{4}$ Circumference of a circle

$= \frac{1}{4} \times 2\pi r = \frac{\pi r}{2}$

For $\frac{1}{4}^{th}$ rotation time = 1 sec

$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{\frac{\pi r}{2}}{1} = \frac{\pi r}{2}$

(ii) Along AC (half of rotation)

Distance covered = $\frac{1}{2}$ Circumference of a circle

$= \frac{1}{2} \times 2\pi r = \pi r$

Time taken = 2 sec

$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{\pi r}{2}$.

(iii) For one complete revolution

Distance covered = circumference of a circle

$= 2\pi r$

Time taken = 4 sec

$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{2\pi r}{4} = \frac{\pi r}{2}$

(18) (8)

Given the body is covering x% of distance with a speed v_1 & $(100-x)$% with a speed v_2.

(a) $x = 20$ i.e) $20\% = \frac{20}{100} = \frac{1}{5}$ S $\rightarrow v_1 \rightarrow$ time $t_1 = \frac{\frac{S}{5}}{v_1} = \frac{S}{5v_1}$

$80\% = \frac{80}{100} = \frac{4}{5}S \rightarrow v_2 \rightarrow t_2 = \frac{\frac{4S}{5}}{v_2} = \frac{4S}{5v_2}$

$\therefore \langle \text{speed} \rangle = \frac{2v_1v_2}{v_1+v_2} = \frac{\text{Total distance}}{\text{Total time}}$

$= \frac{S}{t_1+t_2} = \frac{S}{\frac{S}{5v_1} + \frac{4S}{5v_2}} \Rightarrow \frac{S}{\frac{S}{5}\left[\frac{1}{v_1} + \frac{4}{v_2}\right]}$

$\Rightarrow \frac{5v_1v_2}{v_2+4v_1}$ [By taking L.C.M]

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(b) Total distance S ; $x = 30$

$x\%$ 100

$s_1 = 30\% = \frac{30}{100} \cdot S = \frac{3}{10} S \rightarrow v_1 \rightarrow t_1 = \frac{s_1}{v_1} = \frac{3S}{10v_1}$

$s_2 = (100-x)\% \Rightarrow 70\% = \frac{70}{100} S = \frac{7}{10} S \rightarrow v_2 ; \; t_2 = \frac{s_2}{v_2} = \frac{7S}{10v_2}$

$$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{S}{t_1 + t_2}$$

$$= \frac{S}{\frac{3S}{10v_1} + \frac{7S}{10v_2}} = \frac{S}{\frac{S}{10}\left[\frac{3}{v_1} + \frac{7}{v_2}\right]} = \frac{10}{\frac{3v_2 + 7v_1}{v_1 v_2}}$$

$$= \frac{10 v_1 v_2}{7v_1 + 3v_2}$$

(c) Total distance S $x = 40$

$s_1 = x\% = \frac{40}{100} S = \frac{2}{5} S \rightarrow v_1 ; \; t_1 = \frac{s_1}{v_1} = \frac{2S}{5v_1}$

$s_2 = (100-x)\% = \frac{60}{100} S = \frac{3}{5} S \Rightarrow v_2 ; \; t_2 = \frac{s_2}{v_2} = \frac{3S}{5v_2}$

$$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{S}{t_1 + t_2}$$

$$= \frac{S}{\frac{2S}{5v_1} + \frac{3S}{5v_2}} = \frac{S}{\frac{S}{5}\left[\frac{2}{v_1} + \frac{3}{v_2}\right]} = \frac{5}{\frac{2v_2 + 3v_1}{v_1 v_2}}$$

$$= \frac{5 v_1 v_2}{2v_2 + 3v_1}$$

(d) Total distance $= S$; $x = 50$

$s_1 = x\% = \frac{50}{100} S = \frac{1}{2} S \rightarrow v_1 ; \; t_1 = \frac{s_1}{v_1} = \frac{S}{2v_1}$

$s_2 = (100-x)\% = \frac{50}{100} S = \frac{1}{2} S \rightarrow v_2 ; \; t_2 = \frac{s_2}{v_2} = \frac{S}{2v_2}$

$$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{S}{t_1 + t_2} = \frac{S}{\frac{S}{2v_1} + \frac{S}{2v_2}}$$

$$= \frac{S}{\frac{S}{2}\left[\frac{1}{v_1} + \frac{1}{v_2}\right]} = \frac{2}{\frac{v_2 + v_1}{v_1 v_2}}$$

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

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(19) First calculate the total time taken for each part of journey

Time for 120 km = $\frac{120}{60}$ = 2 hrs Time = $\frac{\text{distance}}{\text{speed}}$

Time for 180 km = $\frac{180}{90}$ = 2 hrs

Total distance travelled = 120 km + 180 km = 300 km

$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{300}{2+2} = \frac{300}{4} = 75$ kmph

(20) Given Average speed = 60 kmph

distance = 300 km.

Time = $\frac{\text{Total distance}}{\text{Average speed}} = \frac{300 \text{ km}}{60} = 5$ hrs

L Task

CUQ's

(6) The total distance covered by ant is = 2 cm + 1.5 cm + 2.5 cm + 3 cm

= 9 cm

The total time taken = 1 + 1 + 1 + 1 = 4 sec.

$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{9}{4} = 2.25$ cm/sec

$= 2.25 \times 10^{-2}$ m/s

(9) Given radius of circular path = 200 m

Time taken for half revolution = 5 min = 5 × 60 = 300 sec

$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{\pi r}{300}$

$= \frac{22}{7} \times \frac{200}{300} = \frac{44}{7 \times 3} = \frac{44}{21}$ m/s

The distance covered for half rotation = $\frac{1}{2}$ (Circum ference)

$= \frac{1}{2} 2\pi r = \pi r$

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SAQ's

(1) Given in a time $t_1 = 2$ sec, An object moves a distance of $S_1 = 10$m

$$\langle \text{velocity} \rangle = \frac{S_1}{t_1} = \frac{10}{2} = 5 \text{ m/s}$$

In a time $t_2 = 8$ sec, Distance covered $S_2 = 20$m.

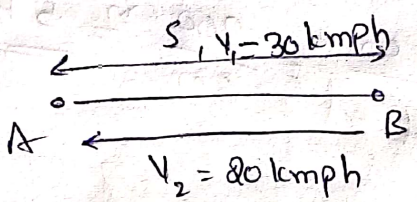
$$\langle \text{velocity} \rangle = \frac{S_2}{t_2} = \frac{20}{8} = 2.5 \text{ m/s}$$

Total distance covered $= S_1 + S_2 = 10 + 20 = 30$m

Total time taken $= t_1 + t_2 = 2 + 8 = 10$ sec

$$\langle \text{velocity} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{30 \text{ m}}{10 \text{ sec}} = 3 \text{ m/s}$$

(2)

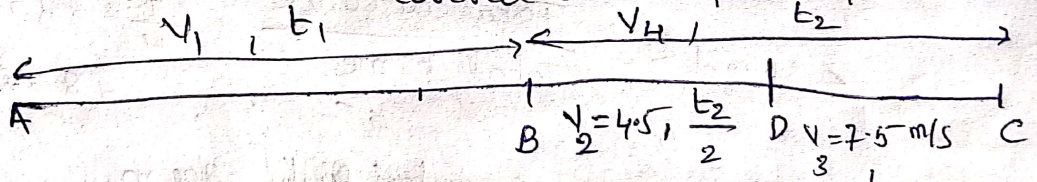


For the entire Journey of Motor cyclist, 1st half [A→B] is covered with a speed V_1, 2nd half [B→A] is covered with a speed V_2.

$$\langle \text{speed} \rangle = \frac{2V_1V_2}{V_1 + V_2} = \frac{2 \times 30 \times 20}{30 + 20}$$

$$= \frac{2 \times 6 \times 20}{5} = 24 \text{ kmph}$$

(3) Given that the first half of the distance is covered with a speed $V_1 = 3$ m/s



For covering 2nd half, B → C, $\frac{t_2}{2}$

of the distance, the effective velocity becomes

$$V_4 = \frac{V_2 + V_3}{2} = \frac{4.5 + 7.5}{2}$$

$$V_4 = \frac{12}{2} = 6 \text{ m/s}$$

For Total Journey

$$\therefore \langle \text{velocity} \rangle = \frac{2V_1V_4}{V_1 + V_4} = \frac{2 \times 3 \times 6}{3 + 6} = \frac{4 \times 12 \times 3}{9} = 4 \text{ m/s}$$

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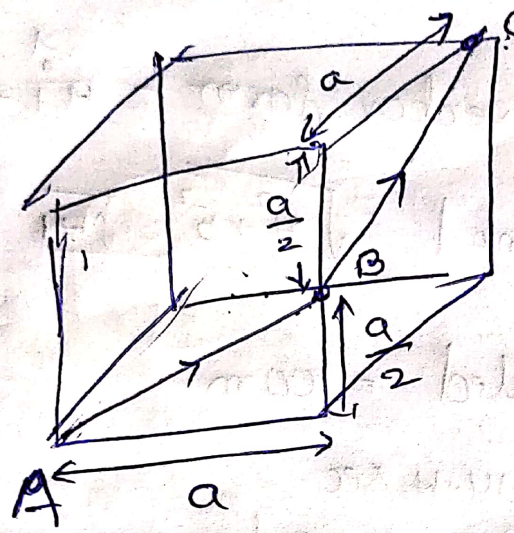
$$\Rightarrow \frac{d}{dx}\sqrt{a^2+x^2} - \frac{d}{dx}\sqrt{(a-x)^2+a^2}$$

$$\Rightarrow \sqrt{a^2+x^2}\,\frac{1}{2}(a^2+x^2)^{-\frac{1}{2}}(2x) - \frac{1}{2}((a-x)^2+a^2)^{-\frac{1}{2}}$$

(4)



The shortest distance or minimum distance covered by the ant to reach diagonally opposite corner is AC

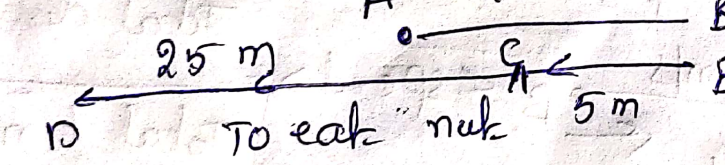
From Fig $AC = AB + BC$

$$= \sqrt{a^2+\left(\frac{a}{2}\right)^2} + \sqrt{a^2+\left(\frac{a}{2}\right)^2}$$

$$\Rightarrow 2\sqrt{a^2+\left(\frac{a}{2}\right)^2} = 2\sqrt{a^2+\frac{a^2}{4}}$$

$$\Rightarrow 2\sqrt{\frac{5a^2}{4}} = 2\frac{\sqrt{5}}{2}a = \sqrt{5}a$$

(5) Direction of motion of a pig to eat apple



Total time taken = 300 sec.

Total distance travelled by the pig = 20+5+25 = 50 m

$$\langle \text{velocity} \rangle = \frac{\text{Total distance}}{\text{Total time}} \quad \frac{50}{300} = \frac{1}{6} = 0.1\overline{6}$$

Total displacement = 20 − 5 − 25

= −10 m [i.e left]

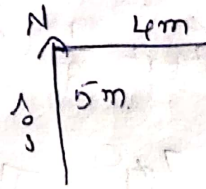
$$\langle \text{velocity} \rangle = \frac{\text{Total displacement}}{\text{Total time}}$$

$$= \frac{10}{300} = \frac{1}{30} = 0.033 \text{ m/s}$$

(6) $$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}}$$

$$= \frac{50}{300} = \frac{1}{6} \text{ m/s}$$

(7) The directions of motion of a body are represented as shown below



∴ The displacement = vector form = $4\hat{i} + 5\hat{j}$ m

∴ |Displacement| = $\sqrt{4^2+5^2} = \sqrt{41} = 6.4$ m

(8)

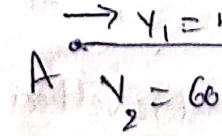
Total distance travelled = 100 m

Time taken = 14.4 sec.

$$\langle \text{velocity} \rangle = \frac{\text{Total distance}}{\text{Time taken}} = \frac{100}{14.4} = 6.94$$

(9) Here the Body travels total distance = 2(AB)

The Ist half of the distance [A→B] is covered with speed 40 m/s and 2nd half of the distance [B→A] covered with a speed of 60 m/s



$$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}}$$

$$\langle \text{speed} \rangle = \frac{2V_1V_2}{V_1+V_2} = \frac{2\times40\times60}{40+60} = \frac{80\times60}{100} = 48 \text{ m/s}$$

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(10) In this problem in a total time of 10 hrs the Bus returns to Delhi.. (i.e) Initial and final positions of the body are same

$\therefore$ Displacement = Final position − Initial position

$\therefore$ $\langle velocity \rangle = \frac{\text{Total displacement}}{\text{Total time}} = \frac{0}{\text{Total time}} = 0$

(11) Total distance covered = 3 km = 3×10^3 m

Time taken = 5 min = 5×60 = 300 sec

(or) $= \frac{5}{60} = \frac{1}{12}$ hrs

(a) speed = $\frac{\text{distance}}{\text{time}} = \frac{3 \times 10^5 \text{ cm}}{300} = 1000$ cm/sec

(b) speed = $\frac{3000}{300} = 10$ m/s

(c) speed = $10 \times \frac{18}{5} = 36$ kmph

1 m/s = $\frac{18}{5}$ kmph

(12) Velocity of a car = 45 kmph.

(2)

(a) In a time = 1 hr → Distance = velocity × time

= 45 × 1 hr = 45 km

(b) If time = 1 min → Distance = $\frac{45 \times 10^3}{60} = 750$ m/min

(c) 45 kmph = $45 \times \frac{5}{18}$ m/s = $\frac{25}{2} = 12.5$ m/s

(15) Radius of Circular Path = 7 m. ; Time taken = 2 sec

Distance = circumference of a circle = $2\pi r$

$= 2 \times \frac{22}{7} \times 7$

= 44 m.

Displacement = 0 For one rotation

speed = $\frac{\text{distance}}{\text{time}} = \frac{44}{2} = 22$ m/s

Displacement = $2r = 2 \times 7 = 14$ m (half rotation)

Velocity = $\frac{\text{Displacement}}{\text{Time}} = \frac{14}{2} = 7$ m/s

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(16) Given car takes T sec to complete $\frac{1}{4}^{th}$ of rotation

(8) L Topic

For Full rotation = 4T sec.

For Half rotation = 2T sec.

For one Rotation - Displacement = 0

$$\langle \text{velocity} \rangle = \frac{\text{Total displacement}}{\text{Total time}} = 0$$

Total distance = Circumference of a circle

$$= 2\pi R$$

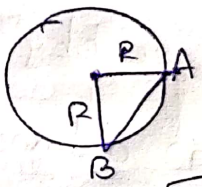
$$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{2\pi R}{4T} = \frac{\pi R}{2T}$$

For Half rotation Displacement = 2R

$$\langle \text{velocity} \rangle = \frac{\text{Total displacement}}{\text{Total time}}$$

$$= \frac{2R}{2T} = \frac{R}{T}$$

For $\frac{1}{4}^{th}$ of Rotation =



Displacement = $AB = \sqrt{R^2+R^2} = \sqrt{2}R$

$$\langle \text{velocity} \rangle = \frac{\text{Total displacement}}{\text{Total time}}$$

$$= \frac{\sqrt{2}\,R}{2T}$$

(17) (i) Here train is moving with ~~uniform speed~~

$$\text{speed} = \frac{\text{Distance}}{\text{Time}} = \frac{240}{4} \text{ or } \frac{120}{3} \text{ or } \frac{3}{\frac{1}{2}}$$

$$= 60 \text{ kmph}$$

(ii) speed of car = $\frac{\text{Distance}}{\text{time}} = \frac{120}{3} = 40$ kmp

(iii) speed of Bus = $\frac{3 \text{ km}}{\frac{1}{2} \text{ hr}} = 6$ kmph

(iv) Total distance travelled by ~~Be~~ Been

$$= 240 \text{ km} + 120 \text{ km} + 3 \text{ km}$$

$$= 363 \text{ km}$$

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(v) Total time Mr Been travelled = $4\text{ hrs} + 3\text{ hrs} + \frac{1}{2}\text{ hr}$

$= 7.5\text{ hr}$

(vi) $\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{363\text{ km}}{7.5\text{ hr}}$

$= 48.4\text{ kmph}$

(18) let the distance between A and B is d km

Time taken to travel from A to B = $\frac{d}{4}$ hrs

Time taken to travel from B to A = $\frac{d}{6}$ hrs

Total distance travelled = $d + d = 2d$

Total time taken = $\frac{d}{4} + \frac{d}{6} = \frac{3d + 2d}{12} = \frac{5d}{12}$ hrs

$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{2d}{\frac{5d}{12}} = \frac{24}{5} = 4.8\text{ kmph}$

Here time taken from $A \to B = \frac{\text{distance}}{V_1} = \frac{d}{4}$ hrs

$B \to A = \frac{d}{V_2} = \frac{d}{6}$ hrs

(19) Distance travelled for 3 hrs = $d_1 = V_1 t_1 = 15 \times 3$

$= 45\text{ km}$

Distance travelled for 2 hrs = $d_2 = V_2 t_2$

$= 20 \times 2 = 40\text{ km}$

Total distance = $d_1 + d_2 = 45\text{ km} + 40\text{ km}$

$= 85\text{ km}$

Total time = $3\text{ hr} + 2\text{ hr} = 5\text{ hrs}$

$\langle \text{speed} \rangle = \frac{\text{Total distance}}{\text{Total time}} = \frac{85\text{ km}}{5\text{ hrs}} = 17\text{ kmph}$

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