A man walks a certain distance. Had he walked half a km an hour faster than he did he would have taken half an hour less, but had he walked half a km an hour slower he would have taken 40 minutes more. Find the distance and his rate of walking.

Solution:

Firstly we express velocity and time of movement. Let v - the velocity the man walked ($\frac{km}{hr}$). Then we can write:

$\left(v + \frac{1}{2}\right) = \frac{1}{2}$ hour less velocity (he walked half a km an hour and taken half an hour less)

$\left(v - \frac{1}{2}\right) = \frac{40}{60}$ hour more velocity (he walked half a km an hour slower and taken 40 minutes more).

Now we express time of movement:

Let t – the time that man walked (hour)

$\left(t - \frac{1}{2}\right)$ - time of walking with faster velocity;

$\left(t + \frac{2}{3}\right)$ - time of walking with slower velocity.

We can express the time and distance with regard to the expression of speed and time of movement. Typically distance expressed as the product of the time by speed ($D = vt$). First, we express the distance if there is rapid movement:

$$vt = \left(v + \frac{1}{2}\right)\left(t - \frac{1}{2}\right)$$

Simplify the expression.

$$vt = vt - \frac{1}{2}v + \frac{1}{2}t - \frac{1}{4}$$

Thus we get the equation:

$$-\frac{1}{2}v + \frac{1}{2}t = \frac{1}{4}$$

Now we express the distance, given the slow movement:

$$vt = \left(v - \frac{1}{2}\right)\left(t + \frac{2}{3}\right)$$

Simplify the expression.

$$vt = vt + \frac{2}{3}v - \frac{1}{2}t - \frac{2}{6}$$

Thus we get the second equation:

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$$\frac{2}{3}v - \frac{1}{2}t = \frac{1}{3}$$

We obtain a system of two equations:

$$\begin{cases} -\frac{1}{2}v + \frac{1}{2}t = \frac{1}{4} \\ \frac{2}{3}v - \frac{1}{2}t = \frac{1}{3} \end{cases}$$

By adding the first equation and the second we get:

$$-\frac{1}{2}v + \frac{1}{2}t + \frac{2}{3}v - \frac{1}{2}t = \frac{1}{4} + \frac{1}{3}$$

Simplify the expression:

$$-\frac{1}{2}v + \frac{1}{2}t + \frac{2}{3}v - \frac{1}{2}t = \frac{1}{4} + \frac{1}{3}$$

$$\frac{1}{6}v = \frac{7}{12}$$

$$v = \frac{7}{2} = 3,5 \ km/hr$$

Thus we have movement velocity, now we can find time of man's movement:

Substitute the found value of velocity in the equation:

$$-\frac{1}{2} \cdot \frac{7}{2} + \frac{1}{2}t = \frac{1}{4}$$

$$-\frac{7}{4} + \frac{1}{2}t = \frac{1}{4}$$

Now we can find the value of time:

$$\frac{1}{2}t = 2 \ => t = 4 \ (hour)$$

We can also check the speed substituting into the second equation:

$$\frac{2}{3} \cdot \frac{7}{2} - \frac{1}{2}t = \frac{1}{3}$$

$$\frac{14}{6} - \frac{1}{2}t = \frac{1}{3}$$

$$\frac{1}{2}t = 2 => t = 4 \ (hour)$$

On the basis of the obtained values we find the distance:

$$D = vt = 3.5 \times 4 = 14 \ (km)$$

Answer: Distance is $14 \ km$, rate of walking is $3.5 \ km/hr$.