

Topic: Speed and Distance

Important formulae and facts of Speed and Distance

Speed is a very basic concept in motion which is all about how fast or slow any object moves. We define speed as distance divided by time. Distance is directly proportional to Velocity when time is constant.

- Speed Distance Time formula mathematically written as:- **Speed** = distance/time

Formula of Time :-time = distance/ Speed

So Formula of time is, time is equal to distance upon speed.

- **Formula of Distance**:-Distance = (Speed * Time)

Distance = Rate x Time

- To find rate, divide through on both sides by *time*:

Rate = Distance/Time

- **Rate is distance** (given in units such as miles, feet, kilometers, meters, etc.) divided by time (hours, minutes, seconds, etc.). Rate can always be written as a fraction that has distance units in the numerator and time units in the denominator, e.g., 25 miles/1 hour.

So distance is simply speed into time.

1. Speed, Time and Distance:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}, \quad \text{Time} = \frac{\text{Distance}}{\text{Speed}}, \quad \text{Distance} = (\text{Speed} \times \text{Time}).$$

2. km/hr to m/sec conversion:

$$x \text{ km/hr} = \left(x \frac{5}{18} \right) \text{ m/sec}$$

3. m/sec to km/hr conversion:

$$x \text{ m/sec} = \left(x \frac{18}{5} \right) \text{ km/h}$$

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$$= x \times \frac{8}{5} \text{ r.}$$

4. If the ratio of the speeds of A and B is $a : b$, then the ratio of the times taken by them to cover the same distance is $\frac{1}{a} : \frac{1}{b}$ or $b : a$.

5. Suppose a man covers a certain distance at x km/hr and an equal distance at y km/hr. Then,

the average speed during the whole journey is $\left(\frac{2xy}{x+y} \right)$ km/h.

Note: All three formulae that formula of speed, formula of time and formula of distance are interrelated.

- **Convert from kph (km/h) to mps(m/sec)**
For converting kph(kilometre per hour) to mps(meter per second) we use following formula

$$x \text{ km/hr} = (x \times 5/18) \text{ m/sec}$$

- **Convert from mps(m/sec) to kph(km/h)**
For converting mps(meter per second) to kph(kilometre per hour) we use following formula

$$x \text{ m/sec} = X \times (18/5) \text{ km/h}$$

- If the ratio of the speeds of A and B is $a : b$, then the ratio of the times taken by them to cover the same distance is $1/a : 1/b$ or $b : a$
- Suppose a man covers a certain distance at x km/hr and an equal distance at y km/hr. Then, the average speed during the whole journey is :- $2xy/(x + y)$
- Relation between time, distance and speed: Speed is distance covered by a moving object in unit time: **Speed= Distance covered/ Time Taken**

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Rule : 1: Ratio of the varying components when other is constant:
Consider 2 objects A and B having speed S_a, S_b .
Let the distance travelled by them are D_a and D_b respectively and time taken to cover these distances be T_a and T_b respectively.

Let's see the relation between time, distance and speed when one of them is kept constant

1. When speed is constant distance covered by the object is directly proportional to the time taken.
ie; **If $S_a=S_b$ then $D_a/D_b = T_a/T_b$**
2. When time is constant speed is directly proportional to the distance travelled. ie; **If $T_a=T_b$ then $S_a/S_b=D_a/D_b$**
3. When distance is constant speed is inversely proportional to the time taken ie if speed increases then time taken to cover the distance decreases. ie; **If $D_a=D_b$ then $S_a/S_b= T_b/T_a$**

Rule 2: We know that when distance travelled is constant, speed of the object is inversely proportional to time taken

1. If the speeds given are in Harmonic progression or HP then the corresponding time taken will be in Arithmetic progression or AP
2. If the speeds given are in AP then the corresponding time taken is in HP

Distance Constant

- **If distance travelled for each part of the journey, ie $d_1=d_2=d_3=...=d_n=d$, then average speed of the object is Harmonic Mean of speeds.**

Let each distance be covered with speeds s_1, s_2, \dots, s_n in t_1, t_2, \dots, t_n times respectively.

$$\text{Then } t_1 = d/s_1$$

$$t_2 = d/s_2$$

$$t_n = d/s_n$$

then, Average Speed= $[(d + d + d + \dots \text{ ntimes})] / [d/s_1 + d/s_2 + d/s_3 + \dots d/s_n]$

Average Speed= $(n) / [(1/s_1 + 1/s_2 + \dots 1/s_n)]$

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Time Constant

- If time taken to travel each part of the journey, ie $t_1=t_2=t_3=...t_n=t$, then average speed of the object is Arithmetic

Let distance of parts of the journey be $d_1, d_2, d_3, ... d_n$ and let them be covered with speed $s_1, s_2, s_3, ... s_n$ respectively.

Then $d_1=s_1 t$, $d_2=s_2 t$, $d_3=s_3 t$, ... $d_n=s_n t$

then , Average Speed = $[(s_1/t + s_2/t + ... s_n/t)/(t + t + ... n \text{ times})]$

Average Speed = $(s_1 + s_2 + s_3 + ... + s_n)/n$

Relative Speed

- If two objects are moving in same direction with speeds a and b then their relative speed is $|a-b|$
- If two objects are moving in opposite direction with speeds a and b then their relative speed is $(a+b)$

Some Question on Above formulas

Ques 1:- A man covers a distance of 600m in 2min 30sec. What will be the speed in km/hr?

Sol:: Speed = Distance / Time

= Distance covered = 600m, Time taken = 2min 30sec = 150sec

Therefore, Speed = $600 / 150 = 4 \text{ m/sec}$

= $4 \text{ m/sec} = (4 \times 18/5) \text{ km/hr} = 14.4 \text{ km/hr}$.

Ques 2:- A car travels along four sides of a square at speeds of 200, 400, 600 and 800 km/hr. Find average speed.?

Sol: Let x km be the side of square and y km/hr be average speed

Using basic formula, Time = Total Distance / Average Speed

$x/200 + x/400 + x/600 + x/800 = 4x/y$

= $25x/2400 = 4x/y$

= $y = 384$

Average speed = 384 km/hr

Ques 3: A motor car does a journey in 10 hrs, the first half at 21 kmph and the second half at 24 kmph. Find the distance?

Sol:

Distance = $(2 \times 10 \times 21 \times 24) / (21+24)$

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$$= 10080 / 45$$

$$= 224 \text{ km.}$$

Ques 4: A boy goes to school at a speed of 3 kmph and returns to the village at a speed of 2 kmph. If he takes 5 hrs in all, what is the distance between the village and the school?

Sol : Let the required distance be x km.

Then time taken during the first journey = $x/3$ hr.

and time taken during the second journey = $x/2$ hr.

$$x/3 + x/2 = 5 \Rightarrow (2x + 3x) / 6 = 5$$

$$\Rightarrow 5x = 30.$$

$$\Rightarrow x = 6$$

Required distance = 6 km.

Ques 5: Walking $\frac{3}{4}$ of his speed, a person is 10 min late to his office. Find his usual time to cover the distance?

Sol : Usual time = Late time / $\{1/ (3/4) - 1\}$

$$= 10 / (4/3 - 1)$$

$$= 10 / (1/3)$$

$$= 30 \text{ minutes.}$$

We hope that the post would have cleared all your doubts related to the topic.