Time, Speed & Distance

Speed, Time and Distance

Speed, Time and Distance: Speed, basically tells us how fast or slow an object moves. It is described as the distance travelled by an object divided with the time taken to cover that distance.

$$\textbf{Speed} = \frac{\textbf{Distance}}{\textbf{Time}}$$

This shows that Speed is directly proportional to distance but inversely proportional to time.

Distance = Speed x Time

$$\textbf{Time} = \frac{\textbf{Distance}}{\textbf{Speed}}$$

From above given equations we can draw three important conclusions:

1. Distance remains constant: If P travels a distance D with S_1 speed in T_1 time and Q travels the same distance D with S_2 speed in T_2 time. Then,

$D = S_1 \times T_1 = S_2 \times T_2$

2. Time remains constant:

$$\frac{D1}{D2} = \frac{S1}{S2}$$

3. Speed remains constant:

$$\frac{D1}{D2} = \frac{T1}{T2}$$

Average Speed:

$$Average\ speed = \frac{Total\ Distance\ travelled}{Total\ time\ taken}$$

Note: Average speed is not the arithmetic mean of the given speeds.

Case 1: When Time is Constant.

The average speed of travelling at two different speeds for the same time span is just the simple average of two speeds.

Let Speed 1 be x km/hr

Let Speed 2 be y km/hr

Therefore,

Average Speed (when time is constant) = $\frac{x+y}{2}$

Example 1: A car is travelling at an average speed of 45 kmph for the 1st hour and at 65 kmph for the next 1 hour. Calculate his average speed.

Solution: As the time is same for both the cases, i.e. 1 hour,

Average speed = $\frac{45+65}{2}$ = 55 km/h.

Case 2: When Distance travelled is Constant.

Let Speed 1 be a km/hr

Let Speed 2 be b km/hr

Average Speed = $\frac{2ab}{a+b}$

Explanation: Let the two speeds be a km/hr and b km/hr.

Let the distance travelled in each case with different speeds be x km.

As we know that, Time = Distance/Speed

Hence, time taken to cover x km at a km/hr will be x/a hrs

And, time taken to cover x km at b km/hr will be x/b hrs

Total time taken = $\left(\frac{x}{a}\right) + \left(\frac{x}{b}\right) = \frac{bx+ax}{ab} = \frac{x(b+a)}{ab}$

And the total distance covered = **2x** km

Therefore,

Average Speed = $\frac{2xab}{x(a+b)} = \frac{2ab}{a+b}$

Example 2: On his way to office, Randhir was travelling at 30 kmph and on the return journey, he was travelling at 45 kmph. What is Randhir's average speed?

Solution:
Let distance = x km
Therefore, Time taken on Randhir's onward journey = $\frac{x}{30}$ hours and
Time taken on his return journey = $\frac{x}{45}$ hours
Therefore,
total time = $\left(\frac{x}{30}\right) + \left(\frac{x}{45}\right)$ hours.
Total distance = 2x km
Average speed= $\frac{2x}{\left(\frac{x}{30}\right)+\left(\frac{x}{45}\right)}$ km/h = 36 kmph

Important Time and Distance Conversions:
- 1 km = 1000 meters
- 1 meter = 100 cm
- 1 hour = 60 minutes
- 1 min = 60 seconds
- 1 hours = 3600 seconds
- 1 mile = 1760 yards
- 1 yard = 3 feet
- 1 mile = 5280 feet
- 1 mph = $\frac{1\times1760}{1\times3600} = \frac{22}{45}$ yards/sec
- 1 mph = $\frac{1\times5280}{1\times3600} = \frac{22}{15}$ ft/sec

Conversion of kmph into m/sec.:
We know that, 1 km = 1000 m and 1 hr = 3600 sec.
So, 1 km/hr = $\frac{1\times1000}{1\times3600}$
On simplifying we get,
1 km/hr = $\frac{5}{18}$ m/sec.

Conversion of m/sec. into kmph:
As we know, 1 km/hr = $\frac{5}{18}$ m/sec.
Rearranging the above equation:
1 m/sec. = $\frac{18}{5}$ km/hr

Concept of Relative speed:
1. When two objects are moving in same direction with S_1 and S_2 speed, then the relative speed will be ($S_1 - S_2$).
2. When two objects are moving in opposite direction with S_1 and S_2 speed, then the relative speed will be ($S_1 + S_2$).
3. When two objects are moving towards each other in opposite directions with S_1 and S_2 speed, then time taken by them to meet each other.
= $\frac{D}{S1+S2}$
Here, **D** is the initial distance between both the objects.
4. When two objects are moving in same direction with S_1 and S_2 speed, then time taken by them to meet each other.
= $\frac{D}{S1-S2}$
Here, **D** is the initial distance between both the objects. And **$S_1 > S_2$.**
5. If two objects P and Q are moving towards each other with speeds S_1 and S_2 respectively from their respective starting points A and B at the same time. After meeting each other they take T_1 and T_2 time to cover the remaining distance to reach Q and P respectively. Then,

$$\frac{S1}{S2} = \sqrt{\frac{T2}{T1}}$$