1. Basics of Speed, Distance & Time

Time, Speed & Distance — Study Notes (Part 1 of 6)

Core Formulas

These three formulas are the foundation for every problem in this topic — everything else is a variation of them.

Speed = Distance ÷ Time
Distance = Speed × Time
Time = Distance ÷ Speed

Unit Conversion

1 km = 1000 m, and 1 hour = 60 × 60 = 3600 seconds.

km/hr → m/sec: multiply by 5⁄18
m/sec → km/hr: multiply by 18⁄5

Example 1
Convert 36 km/hr to m/sec.
36 × (5/18) = 10 m/sec

Example 2
Convert 50 m/sec to km/hr.
50 × (18/5) = 180 km/hr

Average Speed

Average Speed is always Total Distance ÷ Total Time — never simply the average of two speeds, unless the distance covered at each speed is equal.

Average Speed = Total Distance ÷ Total Time

Case 1 — Time of Travel is Different

Example 3
A travels at 40 km/hr for 2 hrs. B travels at 60 km/hr for 3 hrs. Find their average speed.
Average Speed = [40(2) + 60(3)] / (2 + 3) = (80 + 180) / 5 = 260/5
Answer: 52 km/hr

Case 2 — Time of Travel is the Same

Example 4
A travels at 40 km/hr and B at 60 km/hr, each for 2 hours. Find the average speed.
Average Speed = [40(2) + 60(2)] / (2 + 2) = 200/4 = 50 km/hr
Shortcut: when time is equal, Average Speed = (Speed1 + Speed2) / 2 = (40+60)/2 = 50 km/hr

Case 3 — Distance of Travel is Constant (To-and-Fro)

Example 5
Going to college your speed is 40 km/hr; returning it is 60 km/hr. Find the average speed.

Assume distance = LCM(40, 60) = 120 km. Going takes 3 hrs, returning takes 2 hrs.
Average Speed = (120 + 120) / (3 + 2) = 240/5 = 48 km/hr

General formula for two equal-distance legs at speeds x and y:

Average Speed = 2xy / (x + y)

For three equal-distance legs at speeds x, y, z:

Average Speed = 3xyz / (xy + yz + zx)

Common mistake: using (x+y)/2 when the DISTANCE is constant. That shortcut only works when the TIME is constant (Case 2).

Speed Changes → Excess/Deficit Time Method

If distance is constant and speed changes to a fraction of the usual speed, time changes to the reciprocal fraction of the usual time. This lets you solve for the extra time taken directly.

Example 6
A person's speed drops to 5/7 of his usual speed, making him 16 minutes late. Find his usual time.
New time becomes 7/5 of usual time T. Excess = (7/5 – 1)T = (2/5)T = 16 min → T = 40 minutes.
Shortcut: Total time = (slower-fraction-numerator × excess time) / (difference of numerator & denominator) = (5×16)/(7−5) = 40 minutes

"Reaching Late / Early" (Office-Time) Problems

A very common pattern: travelling at one speed makes you late, a faster speed makes you early. Set up the time difference equation to find the distance.

Example 7
At 20 km/hr a man reaches office 5 min late; at 30 km/hr he reaches 5 min early. Find the distance.
Total time difference = 10 minutes = 1/6 hour.
d/20 − d/30 = 1/6 → d/60 = 1/6 → d = 10 km

Multi-Leg Journeys

Example 8
A journey covers 210 km at 30 km/hr, then 140 km at 70 km/hr. Find the average speed for the whole trip.
Time for first leg = 210/30 = 7 hrs. Time for second leg = 140/70 = 2 hrs. Total time = 9 hrs.
Average Speed = 350/9 = 38.88 km/hr

✎ Practice Questions

1. Rahul covers 600 km in 5 hours. If he increases his speed by 30 km/hr, how long will he take to cover 750 km at the new speed?
2. Walking at 3 km/hr, Meera reaches the station 30 minutes after her usual departure time; walking at 6 km/hr, she reaches at her usual time. Find the distance to the station.
3. A car's speed decreases to 3/4 of its usual speed, making the journey 20 minutes longer than usual. Find the usual time.
4. A man reaches his office 4 minutes late when walking at 20 km/hr, and 2 minutes early when walking at 25 km/hr. Find the distance to his office.

5. A cyclist travels the first hour at speed S, the next two hours at 2S, and covers a certain distance. In a second scenario he travels all three hours at S and covers 120 km less overall. Given this, find the average speed of the first scenario.

6. A man walks from home to his office, reaching 20 min early if he doubles his usual speed of 3 km/hr temporarily to 4 km/hr for part of the journey... (Use the 'usual speed & time' method: if $S \times T = (3/4)S \times (T+20)$, find the usual time T.)

✓ Answer Key

1. New speed = 150 km/hr → Time to cover 750 km = 5 hours
2. d = 3 km
3. Usual time = 60 minutes
4. Distance = 10 km
5. Average speed = 100 km/hr
6. Usual time T = 60 minutes