Time, Speed & Distance

~ Quantitative Aptitude · SSC Exams ~

← circled = key formulas!

TSD is the base chapter for trains, races & relative-motion questions. Master the golden relation Distance = Speed × Time — every sum here is just this equation wearing a costume.

① Speed, Distance & Time

The master triangle

- **Speed (S) = Distance (D) ÷ Time (T)**
- **Distance = Speed × Time** · **Time = Distance ÷ Speed**

Cover any one letter in a D/S·T triangle to see the formula for it. Know any two → find the third.

Worked example — Delhi to Chandigarh

A man travels from Delhi to Chandigarh at 50 km/h, covering 300 km. Find the time taken.

Step 1 — D = 300 km, S = 50 km/h.

Step 2 — T = D/S = 300/50.

Answer → T = **6 hours**. ✅

Try these

D=180km, S=45km/h → T = **4 h**

S=60km/h, T=3.5h → D = **210 km**

D=100km, T=2h → S = **50 km/h**

D=540km, S=90km/h → T = **6 h**

Golden rule → if speed is in **km/h**, time must be in **hours**; if speed is in **m/s**, time must be in **seconds**. Mixing units is the #1 SSC trap.

② Unit Conversion — km/h ↔ m/s ⇄

Where 5/18 comes from

1 km/h = 1000 m ÷ 3600 s = **5/18 m/s**.

- km/h → m/s: **multiply by 5/18**.
- m/s → km/h: **multiply by 18/5**.

Worked example — convert 90 km/h

Step 1 — 90 × 5/18.

Step 2 — 90/18 = 5, so 5 × 5 = 25.

Answer → 90 km/h = **25 m/s**. ✅ Check: 25 × 18/5 = 90 km/h.

Quick-conversion table — multiples of 18

km/h	18	36	54	72	90	108
m/s	5	10	15	20	25	30

*Every **multiple of 18 km/h** gives a whole number in m/s — a huge time-saver in trains & races questions.*

Try these

15 m/s → **54 km/h**

20 m/s → **72 km/h**

60 km/h → **50/3 m/s** (≈16.7)

1 m/s → **3.6 km/h**

Trap → students often multiply by **18/5** instead of **5/18** (or vice-versa). Sanity check: m/s value should always be **smaller** than the km/h value.

③ Direct & Inverse Proportion ⚖

Two rules to memorise

- **Distance constant** → Speed ratio is **inversely** proportional to Time ratio.
- **Time constant** → Speed ratio is **directly** proportional to Distance ratio.

Worked example 1 — same distance, different speeds

Outward speed 50 km/h, return speed 60 km/h (same distance). Find the ratio of time taken.
Step — time ratio = 1/50 : 1/60.
Answer → multiply by 300 → 6 : 5 = **6 : 5**. ✅

Worked example 2 — same time, different speeds

In the same time, A and B travel at 6 km/h and 8 km/h. Find the ratio of distances covered.
Answer → distance ratio = speed ratio = 6 : 8 = **3 : 4**. ✅

Try these

Speed ratio 4:5 (same D) → time ratio **5:4**

Speed ratio 2:1 (same D) → time ratio **1:2**

Distance ratio 2:3 (same T) → speed ratio **2:3**

Distance ratio 5:2 (same T) → speed ratio **5:2**

Fast shortcut → if speed becomes ½ of the usual value (distance fixed), time **doubles**. If speed becomes double, time is halved. Always flip for a fixed distance.

✓ This one rule (fixed-distance ⇒ inverse ratio) silently powers pages 5 & 6 — the early/late arrival formulas. Learn it well now.

④ Average Speed

Two cases

- **Different distances** → Average Speed = **Total Distance ÷ Total Time**.
- **Same distance, two speeds a & b** → Average Speed = **2ab / (a+b)**.
- **Same distance, three speeds a, b, c** → Average Speed = **3abc / (ab+bc+ca)**.

Worked example — to and fro journey

A person travels A to B at 30 km/h and returns at 20 km/h. Find average speed.

Step 1 — same distance both ways, use 2ab/(a+b).

Step 2 — 2×30×20 / (30+20) = 1200/50.

Answer → average speed = **24 km/h**. ✅

Mini-example — three equal legs at 6, 4, 3 km/h

3abc/(ab+bc+ca) = 3×6×4×3 / (24+12+18) = 216/54 = **4 km/h**. ✅

Big trap → average speed is **NEVER** simply (a+b)/2 unless the TIME spent at each speed is equal (not the distance). For equal distances it is always **less** than the arithmetic mean.

Try these

Equal legs at 40, 60 km/h → avg = **48 km/h**

Equal legs at 10, 15 km/h → avg = **12 km/h**

⑤ Two-Leg Journey Distance ⇄

Formula A — go at x, return at y, total time t

One-way distance $D = xy\,t \,/\, (x+y)$ (from $D/x + D/y = t$)

Worked example — train out, walk back

A man travels by train at 25 km/h and walks back at 3 km/h. Whole journey took 5 h 36 min. Find the one-way distance.

Step 1 — t = 5h36min = $28/5$ h.

Step 2 — $D = (25\times3)/(25+3) \times 28/5 = 75/28 \times 28/5$.

Answer → D = **15 km**. ✅

Formula B — same distance, speed x makes you slower by t hours than speed y

Distance $D = xy\,t \,/\, (y-x)$ (from $D/x - D/y = t$)

Worked example — two speeds, both late

At 10 km/h a man is 20 min late; at 12 km/h he is only 5 min late. Find the distance.

Step 1 — t = difference = $(20-5)$ min = $1/4$ h.

Step 2 — $D = (10\times12)/(12-10) \times 1/4 = 120/2 \times 1/4$.

Answer → D = **15 km**. ✅

Formula A uses a **sum** of speeds (round trip, total time given). Formula B uses a **difference** of speeds (same trip, comparing two attempts). Don't mix them up!

⑥ Early / Late Arrival Problems ⏱

When the same distance is covered at two different speeds and the arrival times differ from the schedule, use one master idea: **$D/x - D/y =$ (time difference)**, with $y > x$.

Situation	Use with x, y (y>x)
Both late (or both early), by different amounts	t = **difference** of the two times
One late, other early (opposite)	t = **sum** of the two times

$D = xyt\ /\ (y-x)$ in both rows above — only the value of t changes.

Worked example — late then early

Walking at 5 km/h, a student is 40 min late; at 7 km/h she is 20 min early. Find the distance & her usual time.

Step 1 — opposite deviations → $t = 40+20 = 60$ min $= 1$ h.

Step 2 — $D = (5\times7)/(7-5) \times 1 = 35/2$.

Answer → $D =$ **17.5 km**; usual time $= D/5 - 40\text{min} = 3.5\text{h} - 0.67\text{h} =$ **2 h 50 min**. ✅

✓ Verify quickly → at 7 km/h, time = 17.5/7 = 2.5h, which is exactly 20 min less than the usual 2h50min. ✅ Matches!

⑦ Relative Speed ⇉

The two rules

- **Same direction** → relative speed = **difference** of the two speeds.
- **Opposite directions** → relative speed = **sum** of the two speeds.

Worked example 1 — same direction

A and B head to the same point Z at 80 km/h and 60 km/h respectively.

Answer → relative speed of A w.r.t. B = 80 − 60 = **20 km/h**. ✅

Worked example 2 — opposite directions

A moves towards point Z at 60 km/h while B moves away from Z at 80 km/h.

Answer → relative speed = 60 + 80 = **140 km/h**. ✅

Try these

Same dir, 45 & 30 km/h → **15 km/h**

Same dir, 100 & 40 km/h → **60 km/h**

Opp dir, 35 & 25 km/h → **60 km/h**

Opp dir, 18 & 22 km/h → **40 km/h**

Time to cover a gap of distance G with relative speed R is simply **G/R** — the single idea behind meeting-point sums (page 8) and every train-crossing sum (pages 9–11).

⑧ Meeting-Point & Two-Body Problems →←

Two people, distance D apart

· **Towards each other** → *meet after* **$t = D / (s_1+s_2)$**.

· **One chasing the other (head start)** → *catches up after* **t = (head-start gap) / (s_2-s_1)**.

Worked example — walking towards each other

A and B are 150 km apart and start walking towards each other at 30 km/h and 20 km/h.

Step 1 — $t = 150 / (30+20) = 150/50$.

Answer → they meet after **3 h**, 90 km from A and 60 km from B. ✅

Worked example — head-start chase

A thief flees at 8 km/h. 30 min later, police give chase at 10 km/h. When is the thief caught (after police start)?

Step 1 — head-start gap $= 8 \times 0.5 = 4$ km.

Step 2 — relative speed (same dir) $= 10-8 = 2$ km/h.

Answer → time $= 4/2 =$ **2 h** after the police start. ✅

💡 *Distance from A at meeting = $s_1 \times t$; always check both parts add up to the total gap D as a quick sanity test.*

⑨ Trains – Crossing a Pole / Man 🚃 |

When a train crosses a **pole, lamp post, or a person standing still**, the object's length is negligible — the train only needs to cover **its own length**.

The rule

Time = Length of train (L) ÷ Speed of train (S)

Worked example – crossing a pole

A train 150 m long runs at 54 km/h. Find the time to cross a pole.

Step 1 — convert: 54 × 5/18 = 15 m/s.

Step 2 — Time = 150 / 15.

Answer → = **10 seconds**. ✅

Try these

- Train 240 m long crosses a pole in 12 s → speed = 240/12 = 20 m/s = **72 km/h**.
- Train at 36 km/h (=10 m/s) crosses a standing man in 9 s → length = **90 m**.

*Always convert speed to **m/s** first when lengths are in metres – this single habit avoids most silly mistakes in the train chapter.*

A running man or cyclist is NOT negligible speed – if the object itself moves, you must use relative speed (see page 11).

⑩ Trains — Platform & Stationary Train 🚃

To cross a **platform, bridge, or a stationary train**, the train must cover **its own length PLUS the other object's length**.

Case	Formula (Time)
Pole / stationary man	L / S
Platform / bridge (length P)	(L+P) / S
Stationary train (length L2)	(L+L2) / S

Worked example — crossing a platform

A train 250 m long crosses a platform 350 m long in 30 seconds. Find the speed.

Step 1 — total distance = 250+350 = 600 m.

Step 2 — speed = 600/30 = 20 m/s.

Answer → = 20 × 18/5 = **72 km/h**. ✅

Worked example — crossing a standing train

A moving train (150 m, 25 m/s) crosses a stationary train (100 m).

Answer → Time = (150+100)/25 = **10 seconds**. ✅

💡 "Crosses completely" and "passes" both mean the whole (L+other) distance. "The train's tail leaves the platform" is the same finishing moment.

⑪ Trains – Crossing Moving Objects 🚃🚃

When the other object is also moving

- Crossing a **moving man / cyclist** → Time = **L / relative speed**.
- Crossing **another moving train** (lengths L1, L2) → Time = **(L1+L2) / relative speed**.
- Relative speed: **same direction** → **difference**; **opposite direction** → **sum**.

Worked example – train & a walking man

(a) Train (180 m, 20 m/s) overtakes a cyclist at 2 m/s, **same direction**: rel. speed = 20−2 = 18 m/s → time = 180/18 = **10 s**.

(b) Train (200 m, 18 m/s) meets a man walking at 2 m/s, **opposite direction**: rel. speed = 18+2 = 20 m/s → time = 200/20 = **10 s**. ✅

Worked example – two trains crossing

Trains of length 120 m & 180 m run at 25 m/s & 15 m/s (sum of lengths = 300 m).

Same direction → rel. speed = 25−15 = 10 m/s → time = 300/10 = **30 s**.

Opposite direction → rel. speed = 25+15 = 40 m/s → time = 300/40 = **7.5 s**. ✅

💡 Same distance to cover, opposite direction is always **faster** to cross than same direction – a great sanity check (7.5 s < 30 s above).

⑫ Races & Head-Start Basics 🏁

Term	Meaning
A gives B a start of x m	B only needs to run (L−x) m
A beats B by x m	When A finishes L m, B is x m short
A beats B by t sec	B finishes t seconds after A
Dead heat	Both finish at exactly the same time

Worked example — beaten by distance

In a 100 m race, A beats B by 20 m. A's speed is 5 m/s. Find B's speed.

Step 1 — A's time = 100/5 = 20 s.

Step 2 — in these 20 s, B covers only 100−20 = 80 m.

Answer → B's speed = 80/20 = **4 m/s**. ✅

Worked example — beaten by time

In a 200 m race, A finishes in 20 s and B finishes in 25 s. By how much distance does A beat B?

Step 1 — B's speed = 200/25 = 8 m/s.

Step 2 — in A's 20 s, B covers 8×20 = 160 m.

Answer → A beats B by 200−160 = **40 m** (and by 5 s). ✅

✓ *A race is just a relative-speed sum in disguise — the winner's extra distance in the loser's finishing time is the "beaten by" gap.*

Solved Examples – I

Q1. A man travels 360 km at 60 km/h. Find the time taken.
Time = 360/60 = **6 hours**. ✅

Q2. Convert 108 km/h into m/s.
108 × 5/18 = **30 m/s**. ✅

Q3. A car covers a distance in 5 h at 40 km/h. What speed is needed to cover the same distance in 4 h?
Distance = 40×5 = 200 km ∴ new speed = 200/4 = **50 km/h**. ✅

Q4. A man covers a distance at 12 km/h and returns at 8 km/h. Find his average speed.
2×12×8 / (12+8) = 192/20 = **9.6 km/h**. ✅

Q5. Trains 130 m & 110 m long run opposite directions at 60 km/h & 48 km/h. Find time to cross.
Rel. speed = 108 km/h = 30 m/s; sum length = 240 m ∴ time = 240/30 = **8 s**. ✅

Q6. A thief runs at 8 km/h; police start chasing 30 min later at 10 km/h. When is the thief caught?
Gap = 4 km; rel. speed = 2 km/h ∴ time = 4/2 = **2 h** after police start. ✅

✓ Notice Q5 & Q6 reuse the SAME idea — gap ÷ relative speed — whether the gap is train-lengths or a head-start distance.

Solved Examples – II

Q7. A boy walks at 4/5 of his usual speed and reaches school 10 min late. Find his usual time.
Time ratio (new:usual) = 5:4 ∴ extra = ¼T = 10 min ∴ T = **40 minutes**. ✅

Q8. A 250 m train crosses a 350 m platform in 30 s. Find its speed in km/h.
(250+350)/30 = 20 m/s = 20×18/5 = **72 km/h**. ✅

Q9. A and B, 100 km apart, walk towards each other at 15 km/h and 10 km/h. When do they meet?
t = 100/(15+10) = 100/25 = **4 hours**. ✅

Q10. In a 200 m race, A gives B a start of 40 m; they finish together (dead heat). A's speed is 10 m/s. Find B's speed.
A's time = 200/10 = 20 s; B runs 160 m in 20 s ∴ B's speed = 160/20 = **8 m/s**. ✅

Q11. Walking at 6 km/h a man is 15 min early; at 4 km/h he is 15 min late. Find the distance.
t = 15+15 = 30 min = ½ h ∴ D = (4×6)/(6−4) × ½ = 12×½ = **6 km**. ✅

Q12. A train overtakes two men walking at 2 km/h and 4 km/h (same direction), passing them completely in 9 s and 10 s. Find the train's length.
(v−2)×9 = (v−4)×10 ⇒ v = 22 km/h; L = (22−2)×5/18×9 = **50 m**. ✅

Exercise

Pick the correct option — try to finish in 12 minutes!

1. A car travels 240 km in 4 hours. Its speed is:
(a) 40 km/h (b) 60 km/h (c) 50 km/h (d) 45 km/h

2. 72 km/h expressed in m/s is:
(a) 15 m/s (b) 25 m/s (c) 20 m/s (d) 18 m/s

3. For the same distance, if the speed ratio of two journeys is 3:4, the time ratio is:
(a) 3:4 (b) 4:3 (c) 9:16 (d) 1:1

4. A man covers a distance at 20 km/h and returns at 30 km/h. His average speed is:
(a) 25 km/h (b) 24 km/h (c) 26 km/h (d) 22.5 km/h

5. A train 180 m long crosses a pole in 12 seconds. Its speed is:
(a) 54 km/h (b) 45 km/h (c) 60 km/h (d) 50 km/h

6. A 250 m train crosses a 350 m platform in 30 seconds. Its speed (km/h) is:
(a) 60 (b) 72 (c) 80 (d) 90

7. Trains 120 m & 180 m long run same direction at 46 km/h & 36 km/h. Time to cross each other:
(a) 108 s (b) 100 s (c) 90 s (d) 120 s

8. Two people start from the same point, walking opposite directions at 5 km/h & 7 km/h. After 3 h, distance between them is:
(a) 36 km (b) 24 km (c) 30 km (d) 21 km

9. A boy walks at 3/4 of his usual speed and is 20 min late. His usual time is:
(a) 50 min (b) 40 min (c) 60 min (d) 45 min

10. At 5 km/h a man is 10 min late; at 6 km/h he is 5 min early. The distance to office is:
(a) 6 km (b) 7.5 km (c) 9 km (d) 5 km

11. In a 100 m race, A gives B a start of 20 m, beating him by 5 s. A's speed is 5 m/s. B's speed is:
(a) 3 m/s (b) 4 m/s (c) 3.2 m/s (d) 2.5 m/s

12. A train overtakes two cyclists at 4 km/h and 6 km/h (same direction), passing them in 9 s and 10 s. The train's length is:
(a) 50 m (b) 45 m (c) 60 m (d) 55 m

Answer Key ✓

1→b (240/4) · **2→c** (72×5/18) · **3→b** (inverse ratio) · **4→b** (2×20×30/50) · **5→a** (180/12=15m/s) · **6→b** ((250+350)/30) · **7→a** (rel.10km/h=25/9 m/s) · **8→a** ((5+7)×3) · **9→c** (⅓T=20min) · **10→b** (5×6×0.25/1) · **11→c** (80/25) · **12→a** ((v−4)9=(v−6)10⇒v=24, L=50m).

Quick Revision

- ✓ Speed=D/T; km/h→m/s ×5/18, m/s→km/h ×18/5. Distance fixed → Speed:Time inverse; Time fixed → Speed:Distance direct.
- ✓ Average speed (2 equal legs) = 2ab/(a+b); (3 legs) = 3abc/(ab+bc+ca). Relative speed: same dir = difference, opposite dir = sum.
- ✓ Trains: pole/man → L/S; platform/train → (L+P)/S, using relative speed if the other object also moves. Races: "beats by" and "gives a start of" both reduce to a distance or time gap.

Rapid-Fire Extra Examples

- Distance covered in 3 h at 45 km/h → **135 km**.
- Train (90 m, 20 m/s) overtakes a man walking at 2 m/s (same dir) → time = 90/18 = **5 s**.
- In a 500 m race, A finishes in 50 s and wins by 50 m → B's speed = 450/50 = **9 m/s**.

☆ Never late for the exam — keep practising! ☆

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