3 Problem on Trains.

Basis of SDT.

1) always include length of train in whole distance
2) Pole, car, man etc length negligible
3) Relative speed. relating speed of 2 objects (moving) crossing / aligning.
   a) opposite direction (objects)
      relative speed → $x+y$
   b) same direction
      relative speed → $x-y$

1) Two trains with lengths 126m, 119m respectively are moving towards each other. Their speeds are 12m/s and 23m/s respectively. what will be the time needed by trains to cross each other?

Sol :- distance to be crossed = l of train1 + l of train2

$= 126+119$

$= 245$ m

we need Time $T = \frac{D}{S}$

$\Rightarrow T = \frac{245}{S}$ ⇒ we need relative speed

opposite → $x+y$ → $23+12$

RS → 35 m/s

$T = \frac{\cancel{245}\,49}{\cancel{35}\,7}$ **T = 7 seconds**

2) A train passes a stationary pole in 8s, train also passes a 200m long bridge in 28s. What is l and speed of train.

Sols :- Distance crossed by train → pole(l) + train(l)

$D = 200 + l$

D ✗, S ✓, T ✗ — same speed bcs one train cross both pole, bridge

Also time taken to cross pole = T taken to cross 'l' of train because pole is negligible

pole   Bridge

$$S = S$$

$$\frac{D}{T} = \frac{D}{T}$$

$$\frac{L}{8} = \frac{200+L}{28} \Rightarrow 28L = 1600 + 8L$$

$$\Rightarrow 20L = 1600$$

$\boxed{L = 80m}$ → length of train //

$$S = \frac{L}{8} \Rightarrow S = \frac{80}{8}$$

$\boxed{S = 10 m/s}$ speed of train //

3) A train having l of 150m passes a platform of 550m l. Time taken for it is 56 secs. In how much time will train take to pass platform of 250m length?

Sol.
Given l of train = 150   Platform l = 550   Platform = 250

S ✓ D ✗ T ✗
same speed

Platform 1   platform

$$S_1 = S_2$$

$$\frac{D_1}{T_1} = \frac{D_2}{T_2} \Rightarrow \frac{150+550}{56} = \frac{150+250}{T_2}$$

$$\frac{700}{56} = \frac{400}{T} \Rightarrow T_2 = 8 \times 4$$

$\boxed{T_2 = 32 \text{ seconds}}$ //

4) Stations M, N are 276km apart. At exact same time, a train starts from M and other from N towards N and M respectively. These trains meet after 12 hours. The train travelling from M to N is slower by 14km/hr in comparison to the other train. What is speed of slower train?

Sols: Train, → T_1 → M to N (slower by 14 km/hr) → Speed → x
T_2 → N to   Speed → $x + 14$

Time is same when intersect

Distance travelled differ but total distance same

$$D_1 + D_2 = 276$$

$$S_1 \times T_1 + S_2 \times T_2 = 276$$

$$(x \times 12) + (x+14)12 = 276$$

$12x + 12(x+4) = 276$

$12x + 12(x+4) = 276$

$12(x + (x+4)) = 276$

$2x + 4 = 23$

$2x = 19$

$x = 4.5$ km/hr

↳ speed of slower train T_1 //

5) From P and Q, two trains start moving towards each other at the same time. Their speeds are 120 km/hr and 100 km/hr respectively. When the 2 trains meet each other, one train has covered 40 km more than other train. Find distance between P and Q?

Sol: Instead of formula we can use simple logic ~~formula~~

Given T_1 speed = 120 km/h

T_2 speed = 100 km/h So in one hour T_1 moves 20 km fast than T_2

Also in question when they meet faster train travel 40 km $\Rightarrow 20 \times 2$

hence in 2 hours they meet.

dist T_1 in 2 hours $= 2 \times 120 = 240$

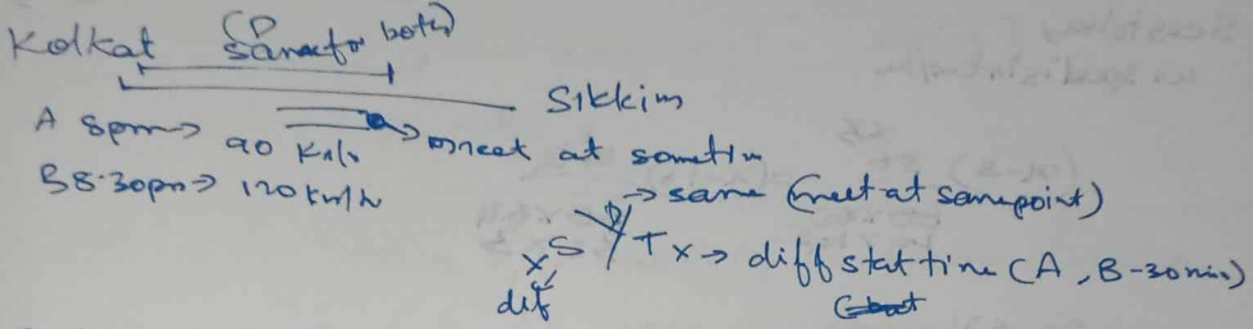
↳ T_2 " $= 2 \times 100 = 200$

Total D $= 240 + 200$

$= 440$ km

distance between P, Q = 440 km //

6) Two trains A and B leave Kolkata for Sikkim at 8.00pm and 8.30pm respectively and run at 90km/hr and 120km/hr, respectively. At what distance from Kolkata, will 2 trains meet?



$D_1 = D_2$

$S_1 \times T_1 = S_2 \times T_2$

$90 \times T_1 = 120 \times T_2$ → also T_2 start half an hour later so $(T_1 - 0.5$ hour)

$90 T_1 = 120 (T_1 - 0.5)$ $\quad T_2 = T_1 - 0.5$

$90 T_1 = 120 T_1 - 60$

$30 T_1 = 60 (2T_1 - 1)$

$3T_1 = 4T_1 - 2$

$\boxed{T_1 = 2 \text{ hrs}}$ → Then distance when meet

⇒ either $T_1 \Rightarrow 90 \times 2 = 180$ //

or $T_2 \Rightarrow 120 \times 1.5 = 180$ //

$\boxed{D = 180 \text{ km}}$

7) A train overtakes two boys who are running at rate of 8 km/hr, 10km/hr in same direction as train. The train completely passes them in 30 sec and 40s respectively. What is length of the train?

Soln: S D T → Time not same 30, 40s

relative speed diff at boys speed diff

Distance is same as both boys are negligible

Distance = l of train (same)

Train cross Boy1   train cross Boy2

$D = D$

$S_1 \times T_1 = S_2 \times T_2$

$(x-8)\times 36 = (x-16)\times 40$

Sees to hay
as speed is in km/hr

> Note:
> Here: Speed of train is relative as 2 moving object
> same direction ⇒ $(x-y)$

$(x-8)\frac{36}{60\times 60} = (x-16)\frac{40}{60\times 60}$

$\frac{(x-8)}{100} = \frac{(x-16)}{90}$

$9x-72 = 10x-160$

$x = 88$ km/hr → speed of train

L of train = D = S × T

= 88 × T ⇒ we know only relative time so use relative speed of any boy

Boy2 relative ⇒ $D = (88-16)\frac{40}{60(60)}$

$= \frac{72\cdot 8}{9010}$ ⇒ $\frac{4}{5}$ ⇒ 0.8 km

Distance (length of train = 0.8 km
= 800 m//

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8) With stoppage, the speed of train is 36 km/hr. However without stoppage, is 40 km/hr? Find out for how many minutes does the train stop per hour?

Soln: logic :- with stop → 36 km
without stop → 40 km ⇒ −4 km

so due to stop we lose 4 km distance

we need time of stop

$$T = \frac{D}{S}$$

$$t = \frac{4\text{ km}}{\text{actual speed of train}}$$

$$T = \frac{4}{40}$$

$$T = 0.1\text{ hour} \times 60 \rightarrow \boxed{T = 6\text{ mins}}$$

$$= \frac{0.1 \times 60}{100}$$

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a) There are 2 trains P, Q moving in same direction. They are of equal length, cross a pole (stationary) in 5 s and 6 s respectively. In how much time would they cross each other?

Sol: we need Time taken by one train to cross another

$$T = \frac{\text{Total Distance take covered}}{\text{Relative speed}}$$

→ add length of both trains

→ two moving trains

length is same for both so '2L'

$$\boxed{T = \frac{2L}{RS}}$$

RS for same direction = $x - y$ (x → Train 1 speed, y → Train 2 speed)

x → stationary pole (L of train) → L in 5 s

y → " " " in 6 s

so S of $x = \frac{L}{5}$, S of $y = \frac{L}{6}$

$$R.S = x - y$$

$$\boxed{RS = \frac{L}{5} - \frac{L}{6}}$$

$$T = \frac{2L}{\frac{L}{5} - \frac{L}{6}} \Rightarrow T = \frac{2L}{\frac{L}{30}} \rightarrow T = 2 \times 30 \text{ s}$$

$$\boxed{T = 60 \text{ seconds}}$$

↓

To cross each other