Physicsaholics

DPP – 7 (Kinematics)

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Q 1. Two trains, each 50m long are travelling in opposite direction with velocity 10 m/s and 15 m/s The time of crossing is: -

(a) $2\ s$ (b) 4 s

(c) $2\sqrt{3}\ s$ (d) $4\sqrt{3}\ s$

Q 2. A police jeep is chasing with, velocity of 45 km/h a thief in another jeep moving with velocity 153 km/h. Police fires a bullet with muzzle velocity of 180 m/s. The velocity it will strike the car of the thief w.r.t. the car of the thief is:

(a) $150\ m/s$ (b) 27 m/s

(c) $450\ m/s$ (d) $250\ m/s$

Q 3. An observer moves with a constant speed along the line joining two stationary objects. He will observe the two objects. Then which of the below statements are correct:

(1) the two objects have the same speed

(2) the two objects have the same velocity

(3) the two objects move in the same direction

(4) the two objects Move in opposite direction

(a) 1, 2, 4 (b) 2, 3, 4

(c) 1, 3, 3 (d) 1, 2, 3

Q 4. Two parallel rail tracks run north-south. Train A moves north with a speed of 54 km/h and train B moves south with a speed of 90 km/h. The relative speed of B with respect to A is:

(a) 40 m/s (towards north) (b) 40 m/s (towards south)

(c) 10 m/s (towards north) (d) 10 m/s (towards north)

Q 5. When a man stands on a moving escalator (moving with constant speed) he goes up in 50 sec. and when he walks up the moving escalator (with constant speed) he goes up in 30 sec. Then the man walks up the stationary escalator in a time of ———sec

(a) 60 s (b) 75 s (c) 90 s (d) 18.75

Q 6. The distance between two particle is decreasing at the rate of 6 m/sec (when moving in just opposite direction). If these particles travel with same speeds and in the same direction, then the separation increase at the rate of 4 m/sec. The particle have speed as

(a) 5 m/s, 1 m/s (b) 4 m/s, 1 m/s

(c) 4 m/s, 2 m/s (d) 5 m/s, 2 m/s

Q 7. Two trains start a distance of 2000m apart. Train one is moving with a constant speed of 30m/s directly towards train 2 which starts from rest and accelerates with a constant acceleration of $5m/s^2$ directly towards train 1. When do the trains meet?

(a) 22.9 s (b) 34.9 s
(c) 30 s (d) 40 s

Q 8. A train starts from rest with constant acceleration $a = 1\,m/s^2$. A passenger at a distance S (behind the train) from the train runs at this maximum velocity of 10 m/s to catch the train at the same moment at which the train starts. If S = 25.5 m and passenger keeps running, find the time in which he will catch the train:

(a) 5 s (b) 4 s
(c) 3 s (d) $2\sqrt{2}$ s

Q 9. An express train is moving with a velocity V_1. Its driver finds another train is moving on the same track in the same direction with velocity V_2. To escape collision, driver applies retardation a on the train. The minimum time of escaping collision will be:

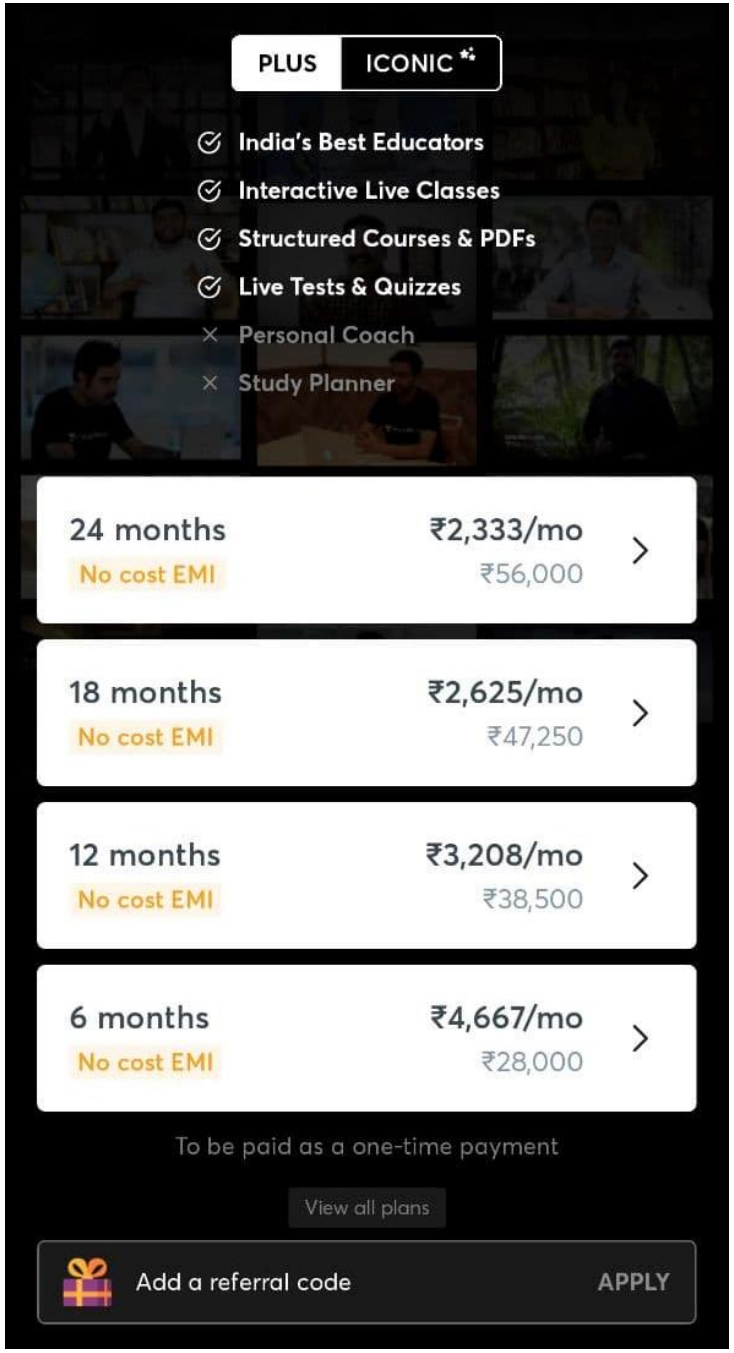
(a) $t = \frac{V_1 - V_2}{a}$ (b) $t = \frac{V_1^2 - V_2^2}{a}$
(c) $t = \frac{V_1^2 + V_2^2}{a}$ (d) $2\sqrt{2}$ s

Q 10. A train 100m long travelling at 40 m/s starts overtaking another train 200m long travelling at 30 m/s. The time taken by the first train to pass the second train completely is:

(a) 30 s (b) 40 s
(c) 50 s (d) 60 s

Answer Key

Q.1) b	**Q.2) a**	**Q.3) d**	**Q.4) b**	**Q.5) b**
Q.6) a	**Q.7) a**	**Q.8) c**	**Q.9) a**	**Q.10) a**



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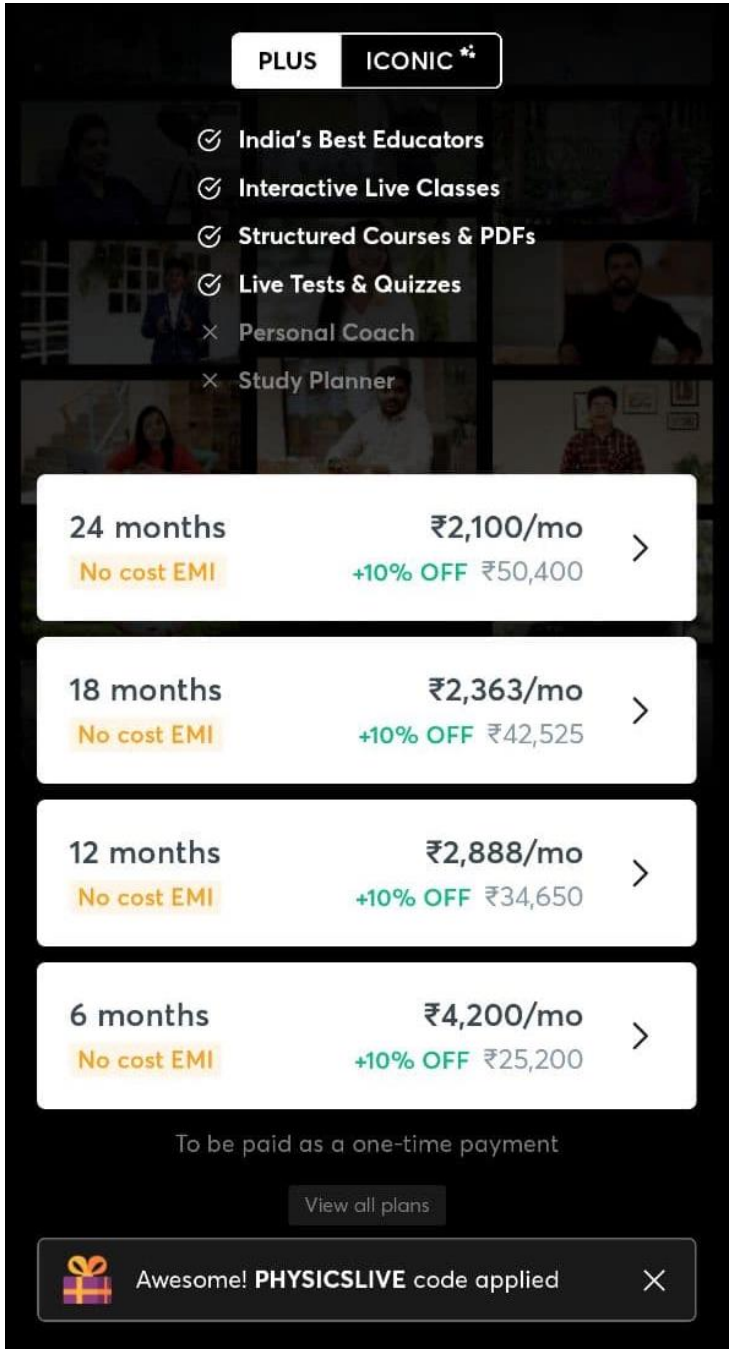
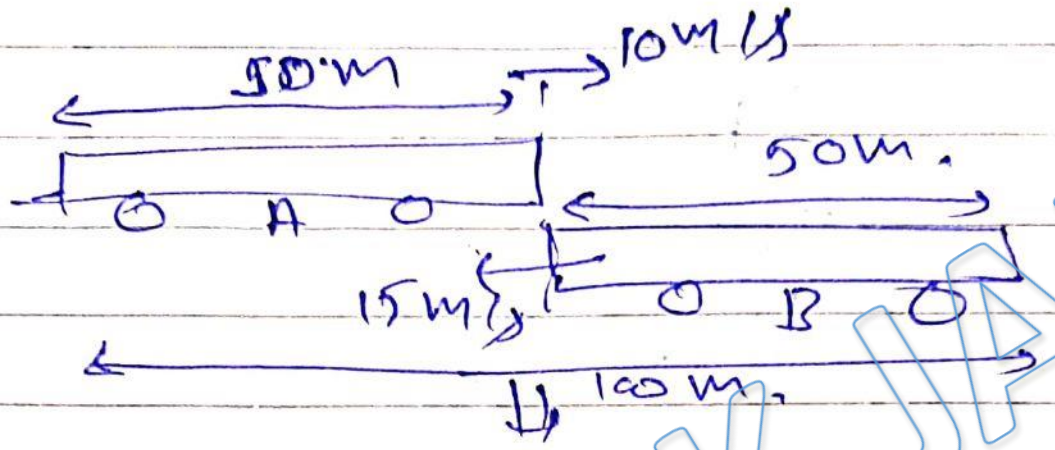


Written Solution

DPP-7 Relative motion in One-Dimension

By Physicsaholics Team

SOLUTION : 1



if B travels with respect to 'A' then it has to cover 100 m to cross the train 'A'

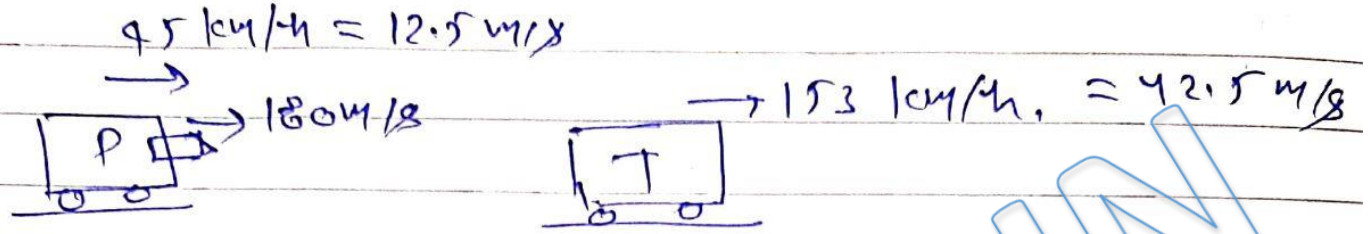
$$V_{A/B} = 15 + 10 = 25 \text{ m/s}$$

$$t = \frac{d}{V_{A/B}} = \frac{100}{25}$$

$$\boxed{t = 4 \text{ sec}}$$

ANS : b

SOLUTION : 2



velocity of bullet w.r.t. police car

$$V_{b/p} = 180 \text{ m/s}$$

$$V_b - V_p = 180 \text{ m/s}$$

$$\therefore V_b = 192.5 \text{ m/s}$$

↳ velocity of bullet w.r.t. ground.

Velocity of bullet w.r.t. Thief's car

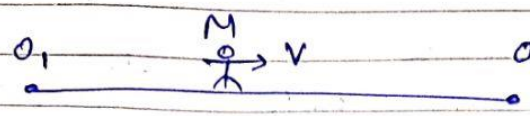
$$V_{b/T} = V_b - V_T$$

$$= 192.5 - 42.5$$

$$\boxed{V_{b/T} = 150 \text{ m/s}}$$

ANS : a

SOLUTION : 3



let observer 'M' moves with velocity
$\vec{V}_m = V\hat{i}$ (w.r.t. ground)

then velocity of object O_1 w.r.t. M

$$\vec{V}_{O_1/M} = \vec{V}_{O_1} - \vec{V}_M = 0 - (V\hat{i})$$

$$\boxed{\vec{V}_{O_1/M} = -V\hat{i}} \quad \& \quad \boxed{V_{O_1/M} = V} \quad \text{--- (1)}$$

↳ velocity ↳ speed

Now, velocity of object O_2 w.r.t. M

$$\vec{V}_{O_2/M} = \vec{V}_{O_2} - \vec{V}_M$$
$$= 0 - V\hat{i}$$

$$\boxed{\vec{V}_{O_2/M} = -V\hat{i}} \quad \& \quad \boxed{V_{O_2/M} = V} \quad \text{--- (2)}$$

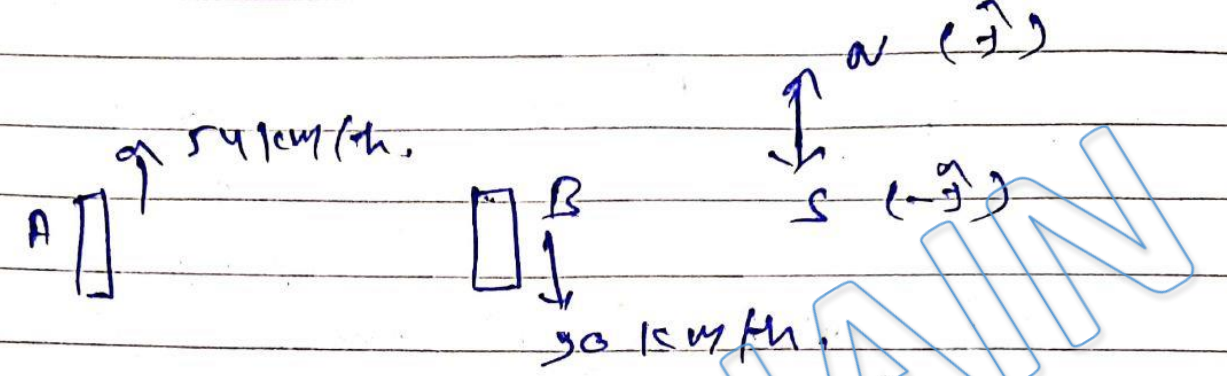
↳ velocity ↳ speed

So, from eq^n (1) & (2)
we can say that
w.r.t. 'M'

O_1 & O_2 moves in same direction and with same speed and same velocity.

ANS : d

SOLUTION : 4



$\vec{V}_A = (54\hat{j})$ km/h $\quad \vec{V}_B = (-90\hat{j})$ km/h.

$\vec{V}_{B/A} = \vec{V}_B - \vec{V}_A$

$= (-90\hat{j}) - (54\hat{j})$

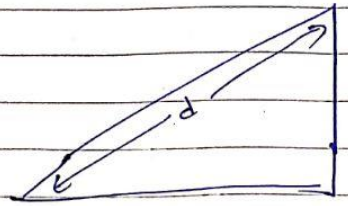
$\vec{V}_{B/A} = (-144\hat{j})$ km/h.

or $V_{B/A} = 144$ km/h (towards South)

$\boxed{V_{B/A} = 40 \text{ m/s (towards South)}}$

ANS : b

SOLUTION : 5



v_e = Speed of escalator w.r.t. ground.

v_m = Speed of man w.r.t. ground.

$v_{m/e}$ = Speed of man w.r.t. escalator.

$v_{m/e} = v_m + v_e$.

$50 = \frac{d}{v_e}$ — ① ⇒

$30 = \frac{d}{v_m + v_e}$ — ②

$\frac{①}{②} = \frac{5}{3} = \frac{v_m + v_e}{v_e}$

$5v_e = 3v_m + 3v_e$

$2v_e = 3v_m$

$\boxed{\frac{v_e}{v_m} = \frac{3}{2}}$

$v_m = \frac{2}{3} v_e$

$t = \frac{d}{v_m} = \frac{d}{\frac{2}{3}v_e} = \frac{3}{2}\frac{d}{v_e}$

& from eq^n ① $50 = \frac{d}{v_e}$

$t = \frac{3}{2}(50) =$

$\boxed{t = 75 \text{ sec}}$

ANS : b

SOLUTION : 6

Let speeds are v_1 & v_2

given, when moving is opposite dirn;

$$v_1 + v_2 = 6 \text{ m/s} \quad -(1)$$

And when moving in same dirn;

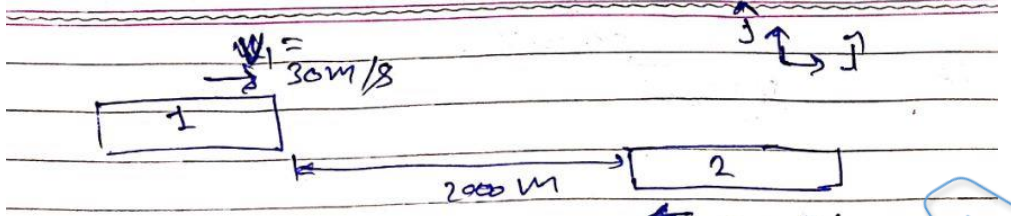
$$v_1 - v_2 = 4 \text{ m/s} \quad -(2)$$

$(1) + (2) \Rightarrow 2v_1 = 10 \Rightarrow \boxed{v_1 = 5 \text{ m/s}}$

& $\boxed{v_2 = 1 \text{ m/s}}$

ANS : a

SOLUTION : 7



initial speed of 1 w.r.t. 2

$$\vec{u}_{1/2} = \vec{u}_1 - \vec{u}_2 = 30\ m/s\ (\hat{j})$$

acceleration of 1 w.r.t. 2

$$\vec{a}_{1/2} = \vec{a}_1 - \vec{a}_2$$

$$= 0 - (-5\hat{j})$$

$$\vec{a}_{1/2} = 5\hat{j}\ m/s^2$$

$$s = ut + \frac{1}{2}at^2$$

$$2000 = u_{1/2}(t) + \frac{1}{2}a_{1/2}t^2$$

$$2000 = 30(t) + \frac{1}{2}(5)t^2$$

$$4000 = 60t + 5t^2$$

$$800 = 12t + t^2$$

$$t^2 + 12t - 800 = 0$$

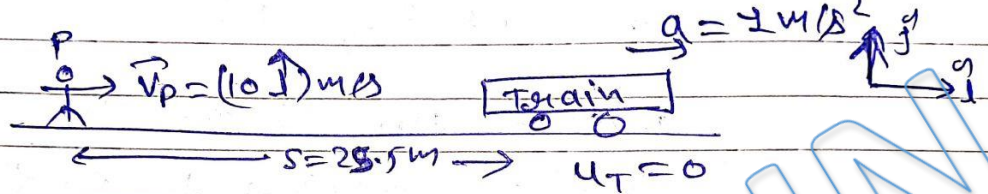
$$t = \frac{-12 \pm \sqrt{12^2 - 4\times1(-800)}}{2(1)}$$

$$t = \frac{-12 \pm \sqrt{144 + 3200}}{2}$$

$$t = \frac{-12 + \sqrt{3344}}{2} \Rightarrow \boxed{t = 22.9\ \text{Sec.}}$$

ANS : a

SOLUTION : 8



initial velocity of passenger w.r.t. Train

$$\vec{v}_{P/T} = \vec{v}_P - \vec{u}_T$$
$$= 10\hat{i} - 0$$
$$\vec{v}_{PT} = (10\hat{i})\ m/s$$

acceleration of passenger w.r.t. Trg's

$$\vec{a}_{P/T} = \vec{a}_P - \vec{a}_T = 0 - 1\ m/s^2(\hat{j})$$
$$\vec{a}_{P/T} = -1\ m/s^2(\hat{j})$$

$$s = ut + \frac{1}{2}at^2$$

$$25.5 = 10(t) - \frac{1}{2}(1)t^2$$

$$25.5 = 10t - \frac{t^2}{2}$$

$$t^2 - 20t + 51 = 0$$

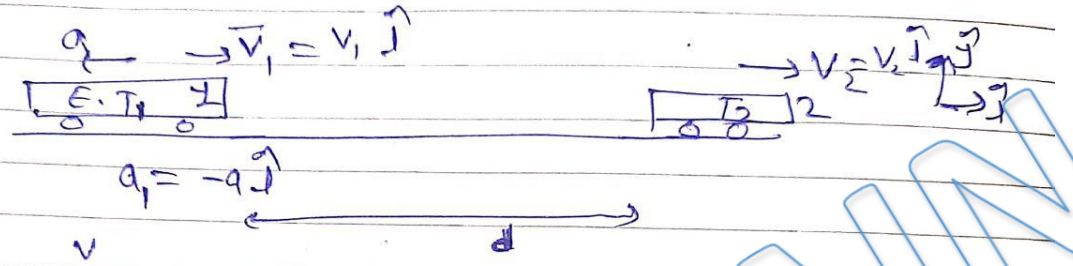
$$t^2 - 3t - 17t + 51 = 0$$

$$t(t-3) - 17(t-3) = 0$$

$t = 3$ sec & $t = 17$ sec.

ANS : c

SOLUTION : 9



initial velocity of Train 1 w.r.t Train 2

$$\vec{v}_{1/2} = \vec{v}_1 - \vec{v}_2 = (v_1 - v_2)\hat{j} \text{ m/s}$$

rel. acceleration; $\vec{a}_{1/2} = \vec{a}_1 - \vec{a}_2 = -a\hat{j} - 0$

$$\vec{a}_{1/2} = -a\hat{j}.$$

after time 't' speed of train 2 w.r.t. train 1 should be zero to avoid collision;

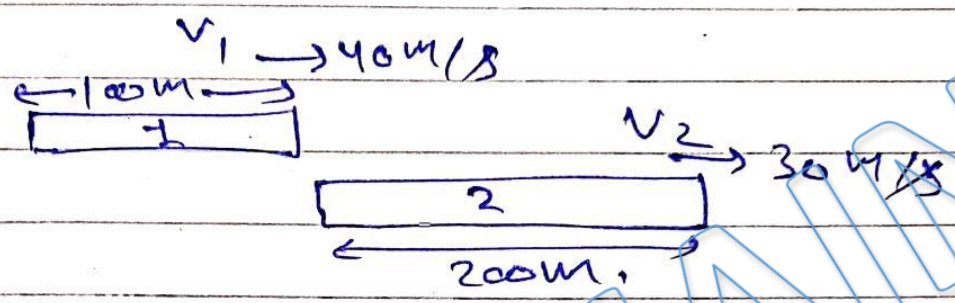
$$v = u + at$$

$$0 = (v_1 - v_2) - at$$

$$\boxed{t = \frac{v_1 - v_2}{a}}$$

ANS : a

SOLUTION : 10



speed of Train 1 w.r.t. Train 2

$$v_{1/2} = v_1 - v_2 = 40 - 30$$

$$\boxed{v_{1/2} = 10\,m/s}$$

min. distance traveled by train 1 to overtake the train -2 is

$$d = 100 + 200 = 300\,m.$$

$$t = \frac{d}{v_{1/2}} = \frac{300}{10}$$

$$\boxed{t = 30\,sec.}$$

ANS : a

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