NCERT DISCUSSION

CHAPTER 3

KINEMATICS

ARJUN NEET

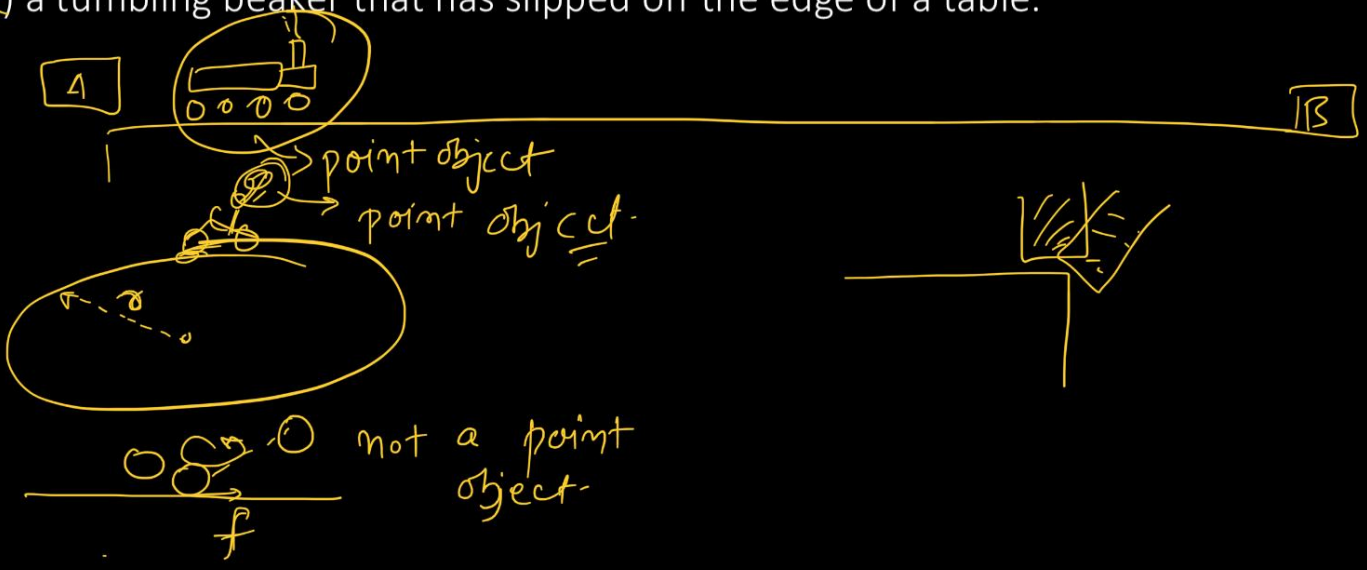
3.1. In which of the following examples of motion, can the body be considered approximately a point object:

(a) a railway carriage moving without jerks between two stations.

(b) a monkey sitting on top of a man cycling smoothly on a circular track.

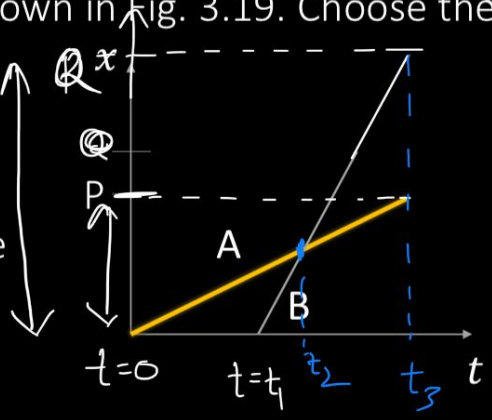
(c) a spinning cricket ball that turns sharply on hitting the ground.

(d) a tumbling beaker that has slipped off the edge of a table.



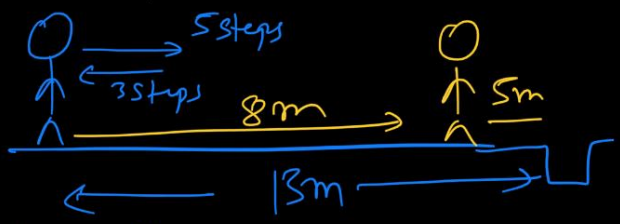
3.2. The position-time (x-t) graphs for two children A and B returning from their school O to their homes P and Q respectively are shown in Fig. 3.19. Choose the correct entries in the brackets below ;

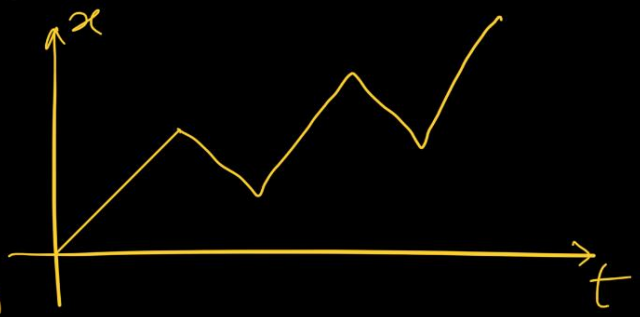
(a) (A/B) lives closer to the school than (B/A)
(b) (A/B) starts from the school earlier than (B/A)
(c) (A/B) walks faster than (B/A)
(d) A and B reach home at the (same/different) time
(e) (A/B) overtakes (B/A) on the road (once/twice).



(a) A lives closer
(b) A starts early
(c) slope of B > slope of A ∴ B is faster than A
(d) Same
(e) B overtakes A once at t_2

3.4. A drunkard walking in a narrow lane takes 5 steps forward and 3 steps backward, followed again by 5 steps forward and 3 steps backward, and so on. Each step is 1 m long and requires 1 s. Plot the $x - t$ graph of his motion. Determine graphically and otherwise how long the drunkard takes to fall in a pit 13 m away from the start.





In 1st 8 sec $= 5m - 3m = 2m$

next '' '' $=$ $2m$

'' '' $2m$

'' '' $2m$

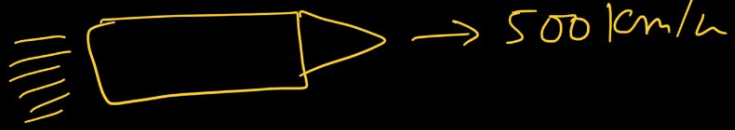
32 sec $8m$

next 5 sec : 5 steps : $8 + 5 = 13m$ falls in pit

37 sec

3.5. A jet airplane travelling at the speed of 500 km h^{-1} ejects its products of combustion at the speed of 1500 km h^{-1} relative to the jet plane. What is the speed of the latter with respect to an observer on the ground ?

$\vec{V}_{gp} = -1500$ kmph



$\vec{V}_{gp} = -1500$ kmph

$\vec{V}_{go} - \vec{V}_{po} = -1500$

$\vec{V}_{go} = -1500 + \vec{V}_{po} = -1500 + 500 = -1000$ kmph.

3.6. A car moving along a straight highway with speed of 126 km h^{-1} is brought to a stop within a distance of 200 m. What is the retardation of the car (assumed uniform), and how long does it take for the car to stop ?

$S = \frac{u^2}{2a}$ $\therefore$ $a = \frac{u^2}{2s} = \frac{35 \times 35}{2 \times 200} = 3.06\ m/s^2$

$u = 126 \times \frac{5}{18} = 35\ m/s.$

$t = u/a = \frac{35}{3.06} = 11.4\ sec.$

3.7. Two trains A and B of length 400 m each are moving on two parallel tracks with a uniform speed of 72 km h^{-1} in the same direction, with A ahead of B. The driver of B decides to overtake A and accelerates by 1 m s^{-2}. If after 50 s, the guard of B just brushes past the driver of A, what was the original distance between them ?

$u = 72 \times 5/18 = 20 m/s$

$a = 1 m/s^2$ S
$t = 50$ sec.

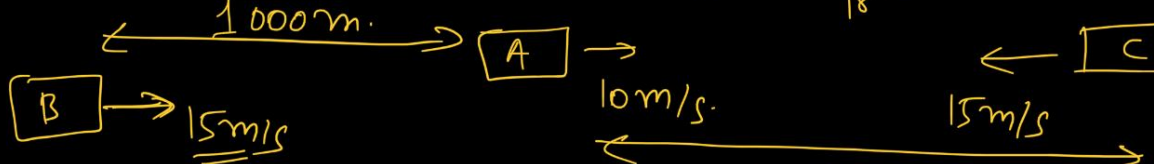
$S_B = 20(50) + \frac{1}{2} \times 1 \times 50^2 = 2250 m.$

$S_A = 20 \times 50 = 1000 m.$

Original distance $= S_B - S_A = 2250 - 1000 = 1250 m.$

3.8. On a two-lane road, car A is travelling with a speed of 36 km h^{-1}. Two cars B and C approach car A in opposite directions with a speed of 54 km h^{-1} each. At a certain instant, when the distance AB is equal to AC, both being 1 km, B decides to overtake A before C does. What minimum acceleration of car B is required to avoid an accident ?

$u_A = 36 \times \frac{5}{18} = 10 m/s$ $u_C = 54 \times \frac{5}{18} = 15 m/s$



$V_{AC} = 10 - (-15) = 25 m/s.$

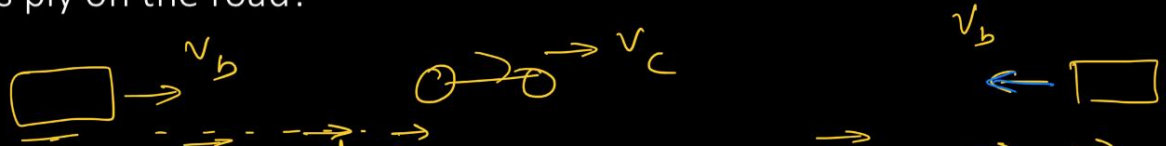
$V_{BA} = 15 - 10 = 5 m/s.$

time to meet A & C $= \frac{1000}{25} = 40 Sec.$

$1000 = 5 \times 40 + \frac{1}{2} \times a \times (40)^2 \Rightarrow 800a = 1000 - 200 = 800$

$a = \frac{800}{800} = 1 m/s^2$

3.9. Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T minutes. A man cycling with a speed of 20 kmh^{-1} in the direction A to B notices that a bus goes past him every 18 min in the direction of his motion, and every 6 min in the opposite direction. What is the period T of the bus service and with what speed (assumed constant) do the buses ply on the road?



$\vec{V}_{bc} = \vec{V}_b - \vec{V}_c$ $\qquad$ $\vec{V}_{bc} = \vec{V}_b + \vec{V}_c$

distance $= (V_b - V_c) \times \frac{18}{60} = V_b \times \frac{T}{60}$ — ①

distance $= (V_b + V_c) \times \frac{6}{60} = V_b \times \frac{T}{60}$ — ②

put in ①

$\frac{(40+20)}{1} = \frac{40 \times T}{60}$

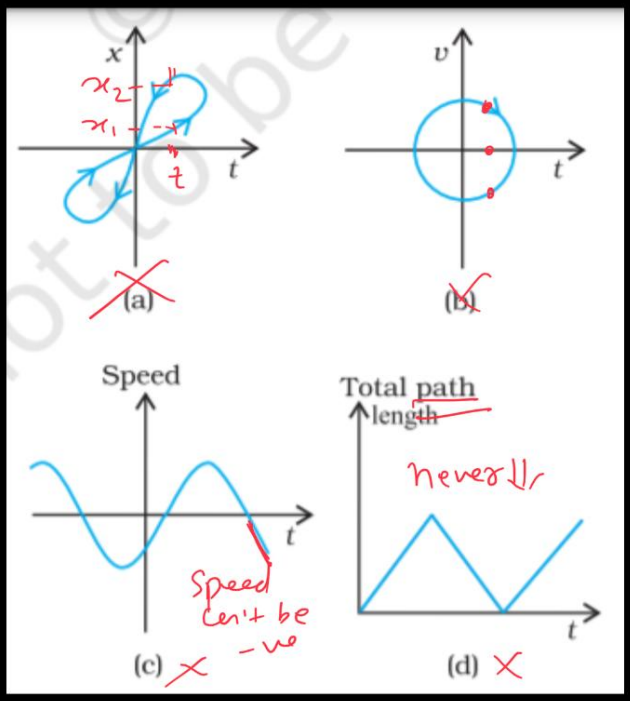
from ① & ②

$3(V_b - V_c)\frac{18}{60} = (V_b + V_c)\times\frac{6}{60}$

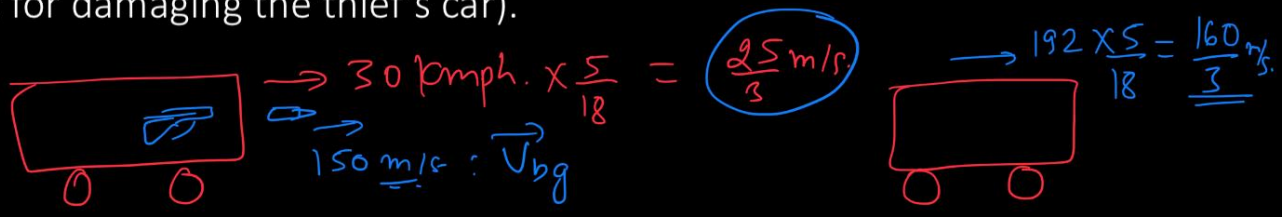
$T = 3$ minutes.

$3(V_b - 20) = (V_b + 20) \Rightarrow 3V_b - 60 = V_b + 20 \Rightarrow 2V_b = 80$ $\quad V_b = 40$ kmph

3.16. Look at the graphs (a) to (d) carefully and state, with reasons, which of these cannot possibly represent one-dimensional motion of particle.



3.18. A police van moving on a highway with a speed of 30 kmh^{-1} fires a bullet at a thief's car speeding away in the same direction with a speed of 192 kmh^{-1}. If the muzzle speed of the bullet is 150 ms^{-1}, with what speed does the bullet hit the thief's car ? (Note: Obtain that speed which is relevant for damaging the thief's car).



Vel. of bullet w.r.t. ground = $150 + \frac{25}{3} = \frac{475}{3}$ m/s.

$V_{bullet\ w.r.t.\ Thief's\ Car} = \frac{475}{3} - \frac{160}{3} = 105$ m/s