PHYSICS

NCERT - NCERT PHYSICS(ENGLISH)

MOTION IN A STRAIGHT LINE

Solved Example

1. A car is moving along a straight (OP). It moves from $O \to P$ in $18\,\text{sec}\,onds$ amd retuns from $P \to Q$ in 6 seconds, $where$OP=360 m and OQ=240 m What are the car the average velcoty and average speed of the car in going (a) from $O \to P$ and back to Q ?

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2. The position of and object moving along x-axis is gi en by $x = a + bt^2$, wher $a = 8.5m$ and b=2.5 ms^(-2) and (t) is measured in ceconds. What is the velcoity $att = 1 = 0$s and $t = 2.0s$? What is the average velocity between $t = 2.0s$ and $t = 4.0s$?

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3. Deduce the equations of unifromly accelerated motion in one dimension by following calculus method.

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4. A ball is thrown vertically upwards with a velcotiy of $20ms^{-1}$ from the top of a multi-storey building. The height of the point fromwher the ball is thrown if 25m from the ground. (a) How high the ball will rise ? And (b) how long will it be before the ball hits the ground ? Take. $g = 10ms^{-2}$.

A. $30m$

B. $20m$

C. $10m$

D. $50m$

Answer: B

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5. Free-fall : Discuss the motion of an object under free fall. Neglect air resistance.

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6. Prove that the distances traversed during equal intervals of time by a body falling from rest, stand to one another in the same ratio as the odd numbers beginning with unity [namely 1: 3: 5: .....].

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7. Stopping distance of vehicles : When brakes are applied to a moving vehicle, the distance it travels before stopping is called stopping distance. It is an important factor for road safety and depends on the initialy velocity (v_0) and the braking capacity, or deceleration $-a$ that is caused by the braking. Derive an expression for stopping distance of a vehicle in terms of v_0 and a.

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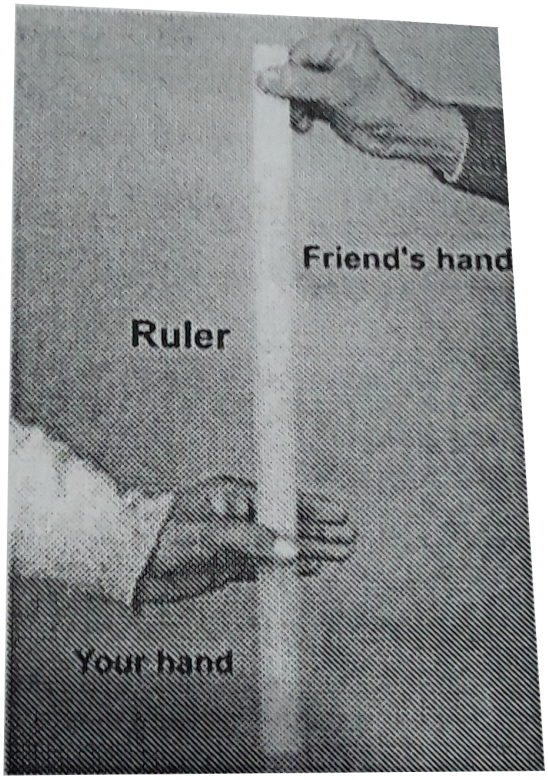
8. When a situation demands our immediate action. It takes some time before we really respond. Reaction time is the time a person takes to observe. Think and

act. For example. If a person is driving and suddenly a boy appears on the road, then the time elapsed before he slams the brakes of the car is the reaction time. Reaction time depends on complexity of the situation and on an individual.

You can measure your reaction time by a simple experiment. Take a ruler and ask your friend to drop it vertically through the gap between your thumb and forefinger(Fig. 3.15). After you catch it, find the distance d travelled by the ruler. In a particular case, d was found

to be 21.0 cm. Estimate reaction time.



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9. Two parallel rail tracks run north-south Train A moves north with a speed of $54kmh^{-1}$ and train B

moves south with a speed of $90kmh^{-1}$. What is the

a. relative velocity of B with respect to A?

b. relative velocity of a monkey running on the roof of the train A against its motion (with its velocity of $18kmh^{1}$ with respect to the train A) as observed by a man standing on the ground?

A. $-40ms^{-1}$, i.e. the train B appears to A to move with a speed of $40ms^{-1}$ from south to north10 ms^(-1)`

B. $40ms^{-1}$, i.e. the train B appears to A to move with a speed of $40ms^{-1}$ from north to south10 ms^(-1)`

C. $-40ms^{-1}$, i.e. the train B appears to A to move with a speed of $40ms^{-1}$ from north to south20 ms^(-1)`

D. $-40ms^{-1}$, i.e. the train B appears to A to move with a speed of $40ms^{-1}$ from north to south10 ms^(-1)`

Answer: D

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Exercise

1. In which of the following exmples of motion, can the body be considered approxinmately a point object :

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

(b) a mondey sistting on top of a man cycling smoothly on a circulat track. (c) a spinning cricket ball that turns sharply on hitting the round . (d) a tumbling beake theat has slopped off the edge of a table ?

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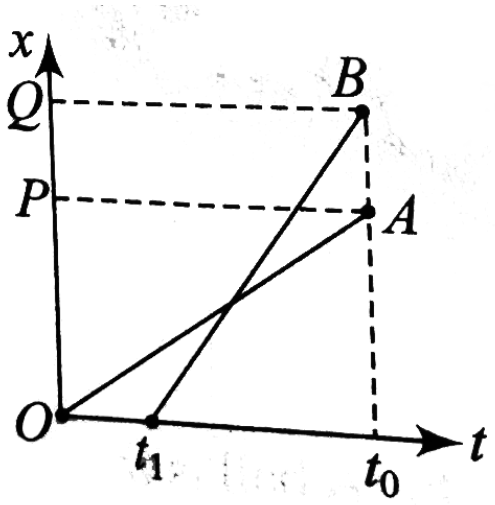

2.

The position-time (x-t) graphs for two children A and B returning from their school O to their homes P and Q respectively along straight line path (taken as x-axis) are shown in figure. Choose the correct statement (s):

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3. A woman starts from her home at 9.00 a.m., walks with a speed of $5kmh^{-1}$ on straight road up to her office $2.5km$ away, stays at the office up to $5.00p.m.$, and returns home by an auto with a speed of $25kmh^{-1}$. Plot the position-time graph of the woman taking home as origin.

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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

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

A. $-1000 \frac{km}{h}$

B. – 1500 (km)/h

C. $1000 \frac{km}{h}$

D. $1500\frac{km}{h}$

Answer: A

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

A. $2.06m/s^2$ $1.44s$

B. $3.06m/s^2$ $11.44s$

C. $3.06m/s^2$ $21.44s$

D. $13.06m/s^2$ $11.44s$

Answer: B

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

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8. On a two lane road , car (A) is travelling with a speed of $36kmh^{-1}$. Tho car B and C approach car (A) in opposite directions with a speed of $54kmh^{-1}$ each . At a certain instant , when the distance (AB) is equal to (AC), both being $1km, (B)decides \rightarrow overtake$ A before C does , What minimum accelration of car (B) is required to avoid and accident.

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9. Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T min. A man cycling with a speed of $20kmh^{-1}$ 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?

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10. A player throwsa a ball upwards with an initial speed of $29.4ms^{-1}$.

(i) What is the direction of acceleration during the upwared motion of the ball?

(ii) What are the velocity and acceleration of the ball at the highest point of its motion?

(iii) Choose the x=0 and t=0 to be the location and time

of the ball at its highest point, vertically downward direction to be the positive direction of X-axis, and give the signs of positive, velocity and acceleration of the ball during its upward, and downward motion.

(iv) To what height does the ball rise and after how long does the ball return to the player's hand?(Take g $= 9.8ms^{-2}$, and neglect air resistance).

A. Downwards $0m/s$ $-10m/s$ negative, negative and Positive $44.1m/s$ $6\sec$

B. Downwards $0m/s$ $-10m/s$ negative, negative and Positive $44.1m/s$ $3\sec$

C. Downwards $10m/s$ $0m/s$ positive, negative and Positive $44.1m/s$ $6\sec$

D. None of the above

Answer: A

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11. Read each statement below carefully and state with reasons and examples if it is true or false ,

(a) with zero speed at an instant may have non-zero acceleration at that instant

(b) with zero speed may have non-zero velocity

(c) with positive constant speed must have zero acceleration

(d) with positive value of acceleration must be speeding up.

A. True False True False

B. False False True False

C. True False True True

D. True False False True

Answer: A

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12. A ball is dropped from a height of a height of 90 m on a floor. At each collsion with the floor , the ball loses one - tenth of its speed . Plot the speed -time graph of its motion between t 0 to 12 s.

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13. Explain clearly, with ezamples, the difference between :

(a) magnitude of displacemnt (sometimes called distance) overand

interval of time, and the total length of the path coverd by a particle over the same interval.

(b) magnitude of average velocity over an intercal of time , and the average speed

over the same interval. [Average speed of a particle over an interval of time is defined as the toal path length

divided by the time intrval]. Show in both (a) and (b) that the second quantity is either greater than or equal

to first.

When is the equality sing true ? [For simplocity, consider one- dimensional motion only]

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14. A man walks on a straight road from his home to a market $2.5km$ away with a speed of $5km/h$. Finding the market closed, he instantly turns and walks back with a speed of $7.5km/h$. What is the (a) magnitude of average velocity and (b) average speed of the man, over the interval of time (i) 0 to 30 min `. (ii) 0 to 50 min (iii) 0 to 40 min ?

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15. The instantaneous speed is always equal to the magnitude of instantaneous velocity. Why?

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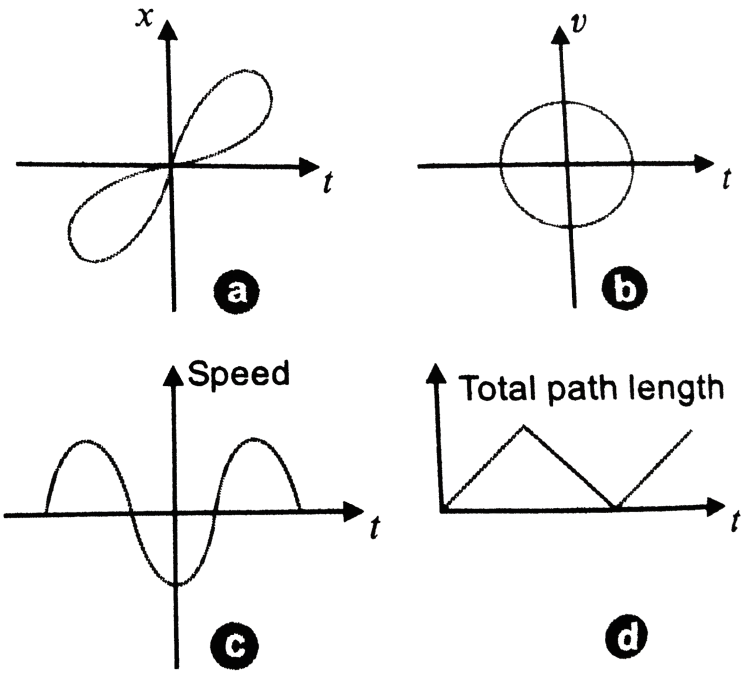
16. Look at the graphs (a) to (d) carefully and state, with reasons, with of these cannot possibly represent one

dimensional motion of a particle.



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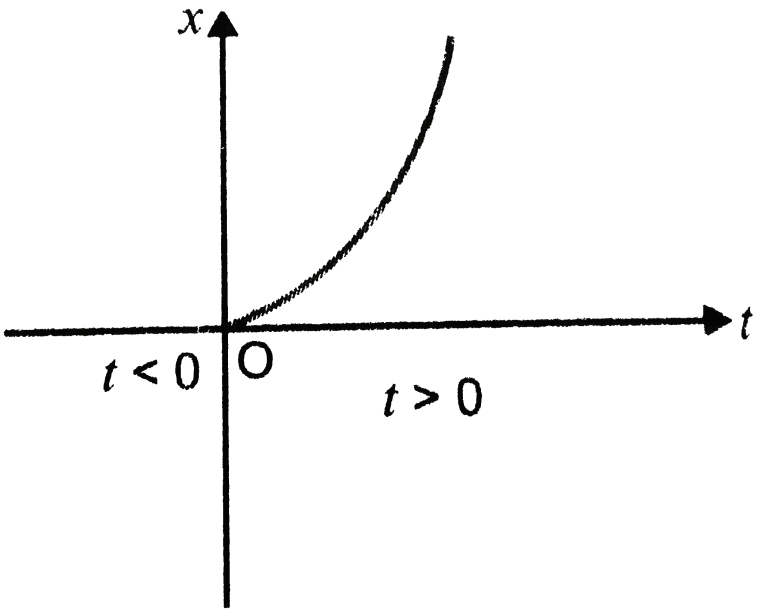
17. Fig. shows $x - t$ plot of one dimensional motion a particle. Is it correct to say from the graph that the particle moves in a straight line for $t < 0$ and on a

parabolic path form $t > 0$? If not, suggest a suitable physical context for this graph.



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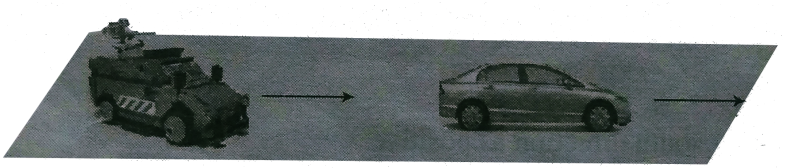
18. A police van moving on a highway with a speed of $30kmh^{-1}$ Fires a bullet at a thief's car speeding away in a same direction with a speed of $192kmh^{-1}$. If the

muzzle speed of the buller is $150ms^{-1}$, with what speed does the bullet hit thief's car? .



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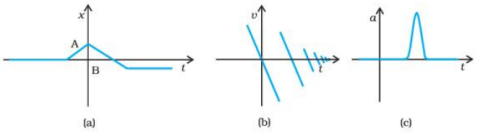
19. Suggest a suitable physical situation for each of the following graph . Fig.



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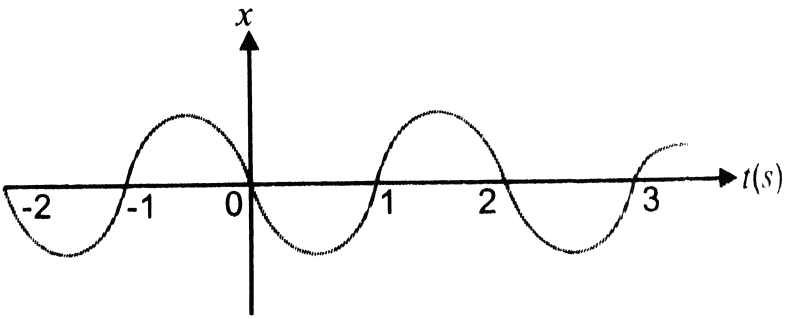
20. Fig gives the $x - t$ plot of a particle executing one dimensional simple harmonic motion. Give the signs of position, velocity and acceleration variables of the particles at $t = 0.3s, 1.2s, -1.2s$,



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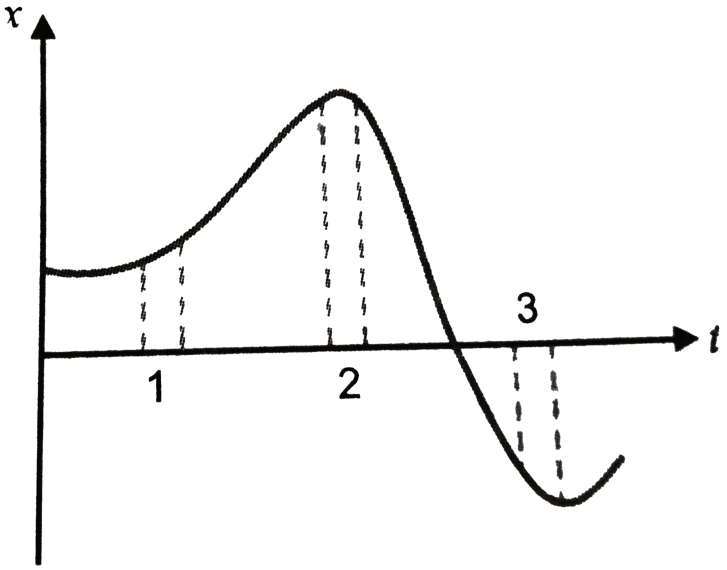
21. Fig. show the $x - t$ plot of a particle in one dimensional motion. Three different equal intervals of time are shown. In which interval the average speed is

greatest and in which it is the least? Give the sign of average speed for each interval.



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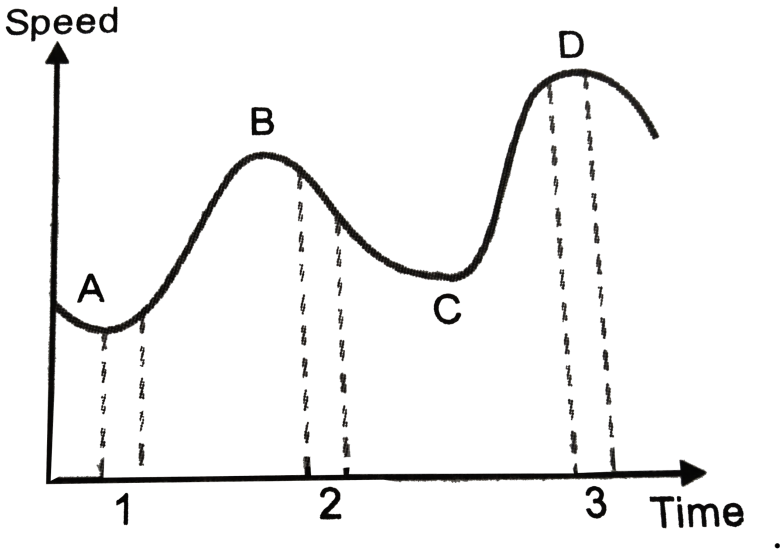
22. Given a speed-time graph of a particle in motion along a constant direction. Three equal intervals of time are shown. In which interval is the average

acceleration greatest in magnitude? In which interval is the average speed greatest? Choosing the positive direction as the constant direction of motion, give the signs of v and a in the three intervals. What are the accelerations at the points A, B, C and D ?



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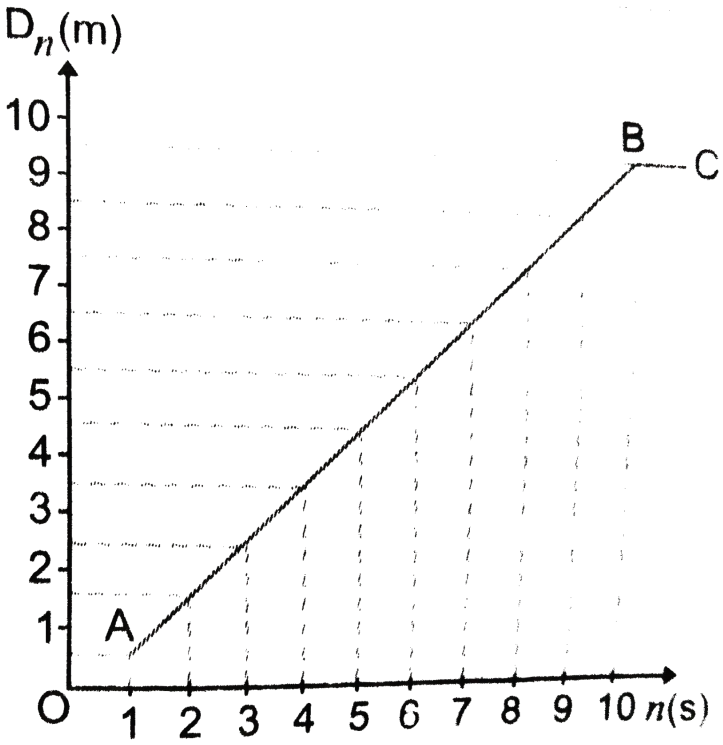
23. A three wheeler starts from rest, accelerates uniformly with $1ms^{-2}$ on a straight road for $10s$ and then moves with uniform velocity. Plot a graph between the distance covered by the vehicle during the n_{th} second (n = 1,2,3, ...) versus n. What do you expect the plot to be during accelerated motion: a straight line or

a parabola?



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24. A boy standing on a stationary lift (open from above) throws a ball upwards with the maximum initial

speed he can, equal to $49ms^{-1}$. How much time does the ball take to return to his hands? If the lift starts moving up with a uniform speed of $5ms^{-1}$ and the boy again throws the ball up with the maximum speed he can, how long does the ball take to return to his hands?

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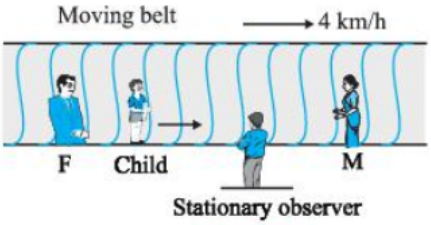
25. On a long horizontally moving belt, a child runs to and fro with a speed $9kmh^{-1}$ (with respect to the belt) between his father and mother located 50m a part on the moving belt. The belt moves with a speed of $4kmh^{-1}$. For an observer on a stationery platform outside, what is the

(i) speed of the child running in the direction of motion

of the belt?

(ii) speed of the child running opposite to the direction of motion of the belt? (iii) time taken by child in (i) and (ii) ?

which of the answers alter if motion is viewed by one of the parents?



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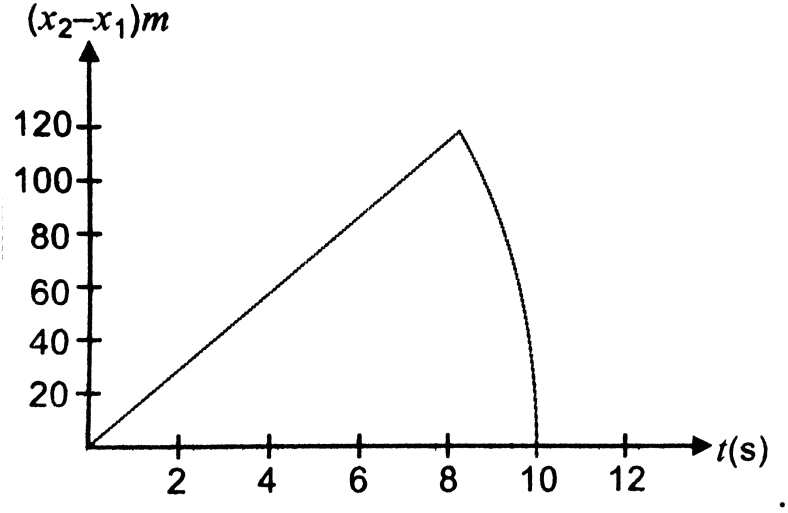
26. Two stones are thrown up simultaneously from the edge of a cliff $200m$ high with initial speeds of $15ms^{-1}$ and $30ms^{-1}$. Verify that the graph shown in Fig. 2 (

NCT). 13 , correctly represents the time variation of the relative position of the second stone with respect to the first. Neglect the air resistance and assume that the stones do not rebound after hitting the ground. Take $g = 10ms^{-2}$.Give equations for the linear and curved parts of the plot.



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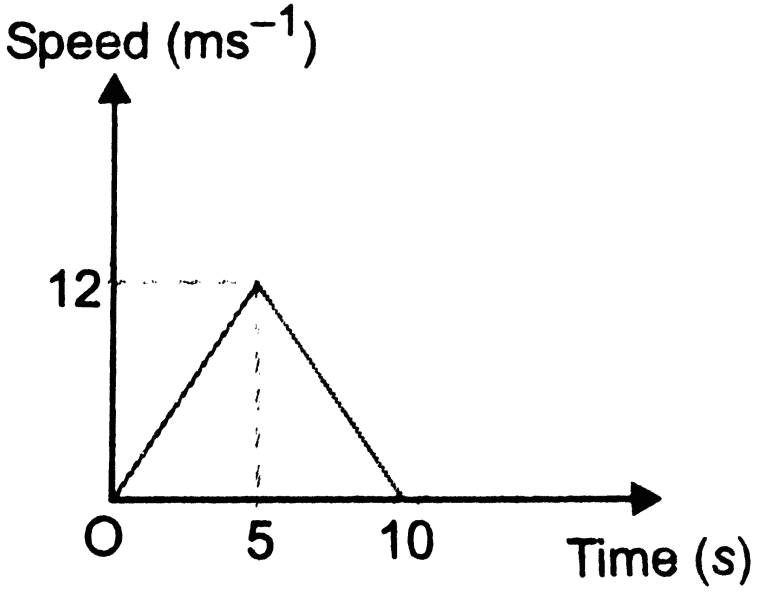
27. The speed-time graph of a particle moving along a fixed direction is shown in the Fig. The distance traversed by the particle between (a) $t = 0s \rightarrow 10s$.



. what is the average speed of the particle over the intervals?

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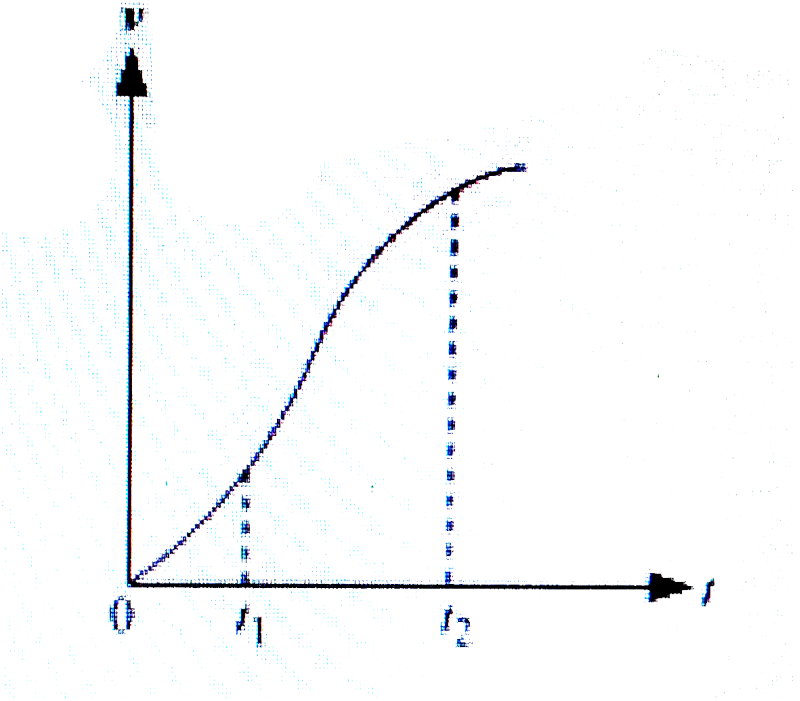
28. The velocity-time graph of a particle in one-dimensional motion is shown in Fig.:



(a) Which of the following formulae are correct for describing the motion of the particle over the time-interval t_1 to t_2:

(a) $x(t_2) = x(t_1) + v(t_1)(t_2 - t_1) + (1/2)a(t_2 - t_1)^2$

(b) $v(t_2) = v(t_1) + a(t_2 - t_1)$

(c) $v_{\text{average}} = (x(t_2) - x(t_1))/(t_2 - t_1)$

(d) $a_{\text{average}} = (v(t_2) - v(t_1))/(t_2 - t_1)$

(e)

$x(t_2) = x(t_1) + v_{\text{average}}(t_2 - t_1) + (1/2)a_{\text{average}}(t_2 - t_1)^2$

(f) $x(t_2) - x(t_1)$ = area under the $v - t$ curve bounded by the t-axis and the dotted line shown.

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