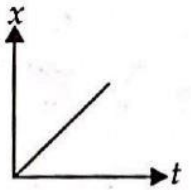
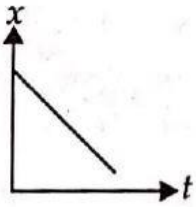
CLASS – 11

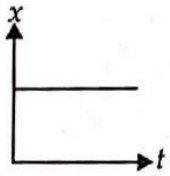
WORKSHEET- Motion in Straight Line

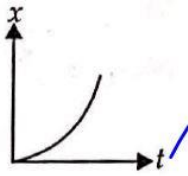
(1 mark questions)

1. Which of the following graphs represents the position-time graph of a particle moving with negative velocity?

(a) 

(b) 

(c) 

(d) 

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2. The velocity of the particle at any time t is given by v = 2t(3 – t)m/s. At what time is its velocity maximum?

(a) 2s (b) 2s (c) 2/3s (d) 3/2s

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3. Can a body have a constant speed and still have a velocity?

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4. Can a body have zero velocity and still be accelerating?

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5. Can the direction of velocity of an object change, when acceleration is constant?

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6. Is it possible for a body to accelerated without speeding up or slowing down? If so, give an example.

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7. Under what condition is the average velocity equal to the instantaneous velocity?

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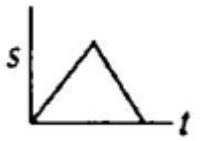
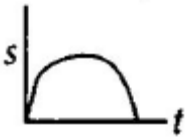
8. Two balls of different masses (one lighter and other heavier) are thrown vertically upward with same initial speed. Which one will rise to the greater height?

9. Two balls of different masses (one lighter and other heavier) are thrown vertically upward with same speed. Which one will pass through the point of projection in their downward direction with the greater speed?

10. Which of the following graphs represents uniform motion? (s is path length).

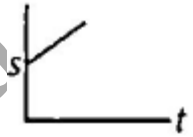


(a)



(b)

(c)



(d)

11. 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

12. 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. Choose the correct entries in the brackets below ;

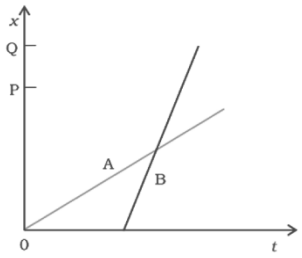
(a) (A/B) lives closer to the school than (B/A)

(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).



13. Read each statement below carefully and state with reasons and examples, if it is true or false: A particle in one-dimensional motion (1 marks each)

(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 constant speed must have zero acceleration,

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

(2 marks questions)

14. If displacement of particle is given by $x = t^2 + 5t + 3$. Find

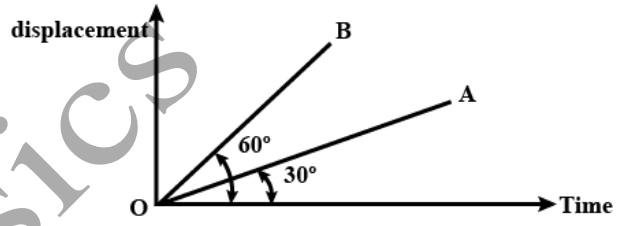
(i) Velocity of the particle at t = 3s and (ii) Average velocity of the particle between t = 1s to t = 3s.

15. Two trains A and B each of length 100m, are running on parallel tracks. One overtakes the other in 20 s moving in the same direction and one crosses the other in 10 s moving in opposite direction. Calculate the velocities of each train.

16. The displacement x of a particle along X-axis is given by $3t+7t^2$. Obtain its velocity and acceleration at t = 2s.

17. A food packet is released from a helicopter which is rising steadily at $2ms^{-1}$. After two seconds (i) what is the velocity of the packet? (ii) How far is it below the helicopter? Take g = 9.8 ms^{-2}.

18. Two straight lines drawn on the same displacement time graph makes angles 30° and 60° with time axis respectively, as shown in figure. Which line represents greater velocity? What is the ratio of the two velocities?



(3marks questions)

19. Derive the equations of motions given below: (i) v = u +at (ii) $s = ut + \frac{1}{2} at^2$ where symbols have their usual meanings.

20. Deduce the following relation: $v^2 - u^2 = 2as$, where symbols have their usual meaning.

21. A woman starts from her home at 9.00 am, walks with a speed of 5km h^{-1} on a straight road up to her office 2.5 km away, stays at the office up to 5.00 pm, and returns home by an auto with a speed of 25 km h^{-1}. Choose suitable scales and plot the x-t graph of her motion.

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

23. 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?

24. 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 ms^{-2}. If after 50 s, the guard of B just brushes past the driver of A, what was the original distance between them ?

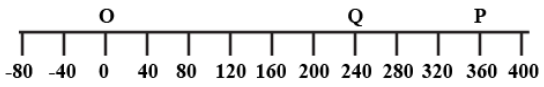
25. On a two-lane road, car A is travelling with a speed of 36 km h^{-1}. Two cars B and C approach car A in opposite directions with a speed of 54 km h^{-1} each. At a certain instant, when the distance AB is equal to AC, both being 1 km, B decides to overtake A before C does. What minimum acceleration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

26. A ball is dropped from a height of 90 m on a floor. At each collision 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.

27. A body travels the first half of the total distance with velocity v_1 and the second half what velocity v_2. Calculate the average velocity.

28. A train moves with a speed of 30 km/h in the first 15 min, with another speed of 40km/h the next 15 min, and then with a speed of 60 km/h in the last 30 min. Calculate the average speed of the train for this journey.

29. A car is moving along X-axis as shown in the figure, it moves from O to P in 18s and returns from P to Q in 6s. What are the average speed of the car in going from (i) O to P and (from O to P and back to Q?



30. The position of an object moving along x-axis is given by $x = a+bt^2$ where a = 8.5m, b = 2.5 m/s^2 and t is measured in seconds. What is its velocity at t = 0s and t = 2s? What is the average velocity between t = 2s and t = 4s?

31. The velocity of a particle is given by the equation $v = 2t^2 + 5$ cms^{-1}.Find (i) the change in velocity of the particle during the time interval between t_1 = 2s and t_2 = 4s (ii) the average acceleration during the same interval and (iii) the instantaneous acceleration at t_2 = 4s.

32. A driver takes 0.20s to apply the brakes after he sees a need for it. This is called the reaction time of the driver. If he is driving a car at a speed of 54 km/h and the brakes cause a deceleration of 6.0 m/s^2, find the distance travelled by the car after he sees the need to put the brakes.

33. A bullet travelling with a velocity of 15 m/s penetrates a tree trunk and comes to rest in 0.4m. Fine the time taken during the retardation.

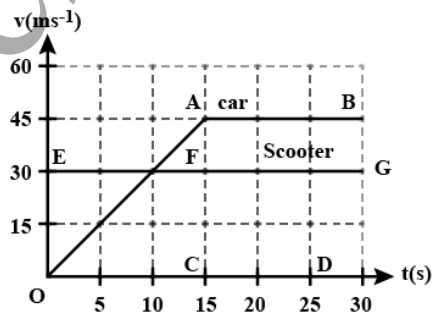
34. Two balls are thrown simultaneously. A vertically upwards with a speed of 20 m/s from the ground, and B vertically downwards from a height of 40m with the same speed and along the same line of motion. At what points do the two balls collide?

(Take g = 9.8 ms^{-2})

35. A rocket is fired vertically from the ground with a resultant vertical acceleration of 10m/s^2. The fuel is finished in 1 min and it continues to move up. What is the maximum height reached?

36. A balloon is ascending at the rate of 14 m/s at a height of 98m above the ground when the food packet is dropped from the balloon. After how much time and with that velocity does it reach the ground? Take g = 9.8 ms^{-2}.

37. As soon as a car just starts from rest in a certain direction, a scooter moving with a uniform speed overtakes the car. Their velocity time graphs are shown in the figure. Calculate (i) the difference between the distances travelled by the car and the scooter in 15s (ii) the time when the car will catch up the scooter and (iii) the distance of car and scooter from the starting point at that instant.



38. Two parallel rail tacks 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. What is the (i) relative velocity of B with respect to A? (ii) relative velocity of ground with respect to B (iii) velocity of a monkey running on the roof of the train A against the motion (with a velocity of 18km/h with respect to the train A) as observed by a man standing on the ground?

39. Draw the following graphs(expected nature only) between distance and time of an object in case of (a) for a body at rest (b) for a body moving with uniform velocity (c) for a body moving with constant acceleration.

40. Draw the following graphs (expected nature only) representing motion of an object under free fall. Neglect their resistance. (a) variation of position with respect to time (b) variation of velocity with respect to time (c) variation of acceleration with respect to time.

41. 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 1m long and requires 1s. Plot the x – t graph of his motion. Determine graphically and otherwise how long the drunkard takes to fall in a pit 13m away from the start.

42. 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 km h^{-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?

43. A player throws a ball upwards with an initial speed of 29.4 m s^{-1} .

(a) What is the direction of acceleration during the upward motion of the ball ?

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

(c) Choose the x = 0 m and t = 0 s 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 position, velocity and acceleration of the ball during its upward, and downward motion.

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

44. Explain clearly, with examples, the distinction between :

(a) magnitude of displacement (sometimes called distance) over an interval of time, and the total length of path covered by a particle over the same interval:

(b) magnitude of average velocity over an interval of time, and the average speed over the same interval. [Average speed of a particle over an interval of time is defined as the total path length divided by the time interval]. Show in both (a) and (b) that the second quantity is either greater than or equal to the first. When is the equality sign true? [For simplicity, consider one-dimensional motion only].

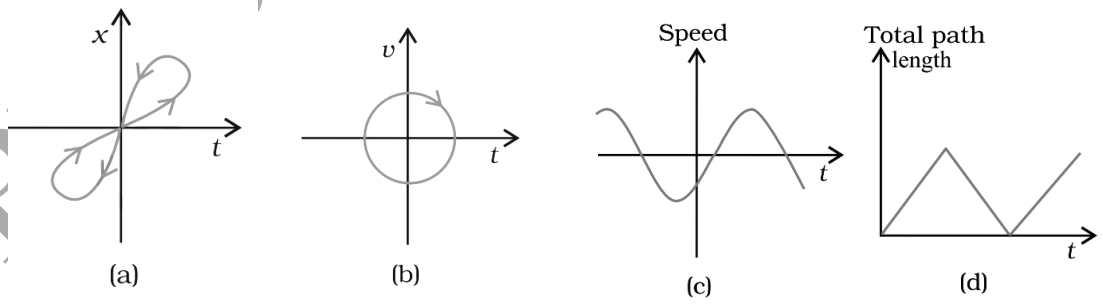
45. A man walks on a straight road from his home to a market 2.5 km away with a speed of 5 km h^{-1}. Finding the market closed, he instantly turns and walks back home with a speed of 7.5 km h^{-1}. What is the

(a) magnitude of average velocity, and

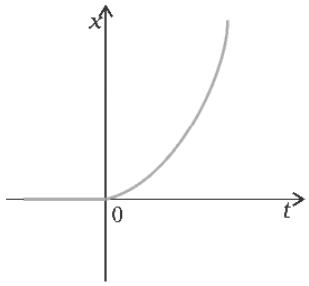
(b) average speed of the man over the interval of time (i) 0 to 30 min, (ii) 0 to 50 min, (iii) 0 to 40 min?

46. In Exercises above, we have carefully distinguished between average speed and magnitude of average velocity. No such distinction is necessary when we consider instantaneous speed and magnitude of velocity. The instantaneous speed is always equal to the magnitude of instantaneous velocity. Why?

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

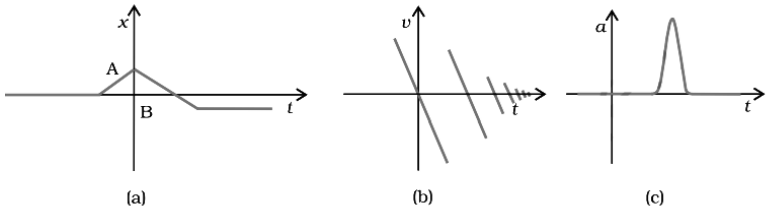


48. Figure shows the x-t plot of one-dimensional motion of a particle. Is it correct to say from the graph that the particle moves in a straight line for $t < 0$ and on a parabolic path for $t > 0$? If not, suggest a suitable physical context for this graph.

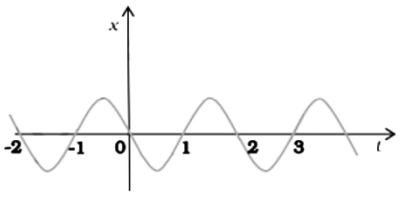


49. A police van moving on a highway with a speed of 30 km h^{-1} fires a bullet at a thief's car speeding away in the same direction with a speed of 192 km h^{-1}. If the muzzle speed of the bullet is 150 ms^{-1}, with what speed does the bullet hit the thief's car?

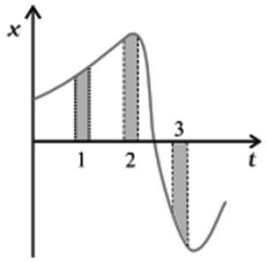
50. Suggest a suitable physical situation for each of the following graphs (Figure):



51. Figure 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 particle at t = 0.3 s, 1.2 s, – 1.2 s.



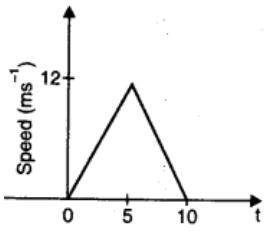
52. Figure gives the x-t plot of a particle in one-dimensional motion. Three different equal intervals of time are shown. In which interval is the average speed greatest, and in which is it the least ? Give the sign of average velocity for each interval.



53. A three – wheeler starts from rest , accelerates uniformly with 1 m s^{-2} on a straight road for 10 s, and then moves with uniform velocity .plot the distance covered by the vehicle during the n^{th} second (n=1,2,3……..) versus n. what do you expect this plot to be during accelerated motion: a straight line or a parabola?

54. A boy standing on a stationary lift (open from above) throws a ball upwards with the maximum initial speed he can, equal to 49 m s^{-1}. How much time does the ball take to return to his hands? If the lift starts moving up with a uniform speed of 5 m s^{-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?

55. The speed-time graph of a particle moving along a fixed direction is shown in Fig. Obtain the distance traversed by the particle between
(a) t = 0 s to 10 s. (b) t = 2 s to 6 s.
What is the average speed of the particle over the intervals in (a) and (b)?



(5 marks questions)

56. Two ends of a train moving with a constant acceleration passes a certain point with velocities u and v. Show that the velocity with which the middle point of the train passes the same point is $\sqrt{(u^2 + v^2)/2}$.

57. In a car race, car A takes time t second less than car B and finishes the finishing point with a velocity v more than that of the car B. Assuming that the cars start from rest and travel with constant acceleration a_1 and a_2 respectively show that $v = t\sqrt{a_1 a_2}$.

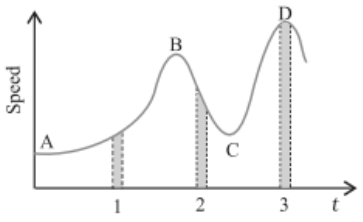
58. A body travelling along a straight line traversed one-half of the total distance with velocity v_0. The remaining part of the distance was covered with a velocity v_1, for half the time and with velocity v_2 for the other half of time. Find the mean velocity averaged over the whole time of motion.

59. A car accelerates from rest at a constant rate α for some time, after which it accelerates at a constant rate β to come to rest. If the total time elapsed is t second, then calculate (i) the maximum velocity attained by the car, and (ii) the total distance travelled by the car in terms of α, β and t.

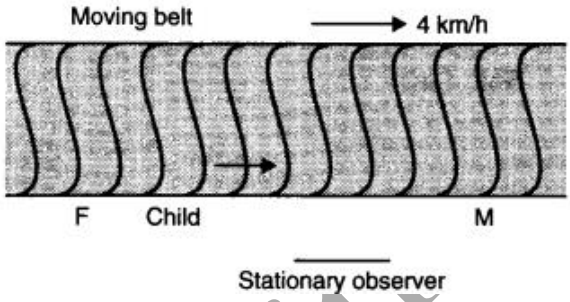
60. A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed from some time t and then decelerates at the rate f/2 to come to rest. If the total distance is 5S, then prove that $S = \frac{1}{2} ft^2$.

61. Derive an equation for the distance covered by a uniformly accelerated body in nth second of its motion. A body travels half its path in the last second of its fall from rest, calculate the time of its fall.

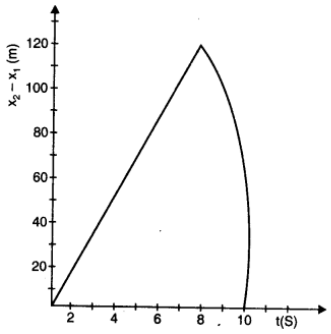
62. Figure gives a speed-time graph of a particle in motion along a constant direction. Three equal intervals of time are shown. In which interval is the average acceleration greatest in magnitude ? In which interval is the average speed greatest ? Choosing the positive direction as the constant direction 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 ?



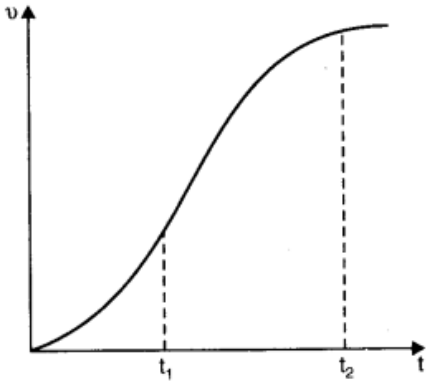
63. On a long horizontally moving belt (Fig.), a child runs to and fro with n speed 9 km h^{-1} (with respect to the belt) between his father and mother located 50 a part on the moving belt. The belt moves with a speed of 4 km h^{-1} . For an observe a stationary platform outside, what is the
(a) Speed of the child running in the direction of motion of the belt?
(b) Speed of the child running opposite to the direction of motion of the belt?
(c) Time taken by the child in (a) and (b)?
Which of the answers alter if motion is viewed by one of the parents?



64. Two stones are thrown up simultaneously from the edge of a cliff 200 m high with initial speeds of 15 ms^{-1} and 30 ms^{-1}. Verify that the graph shown in Fig. correctly represents the time variation of the relative position of the second stone with respect to the first. Neglect air resistance and assume that the stones do not rebound after hitting the ground. Take g = 10 ms^{-2}. Give the equations for the linear and curved parts of the plot.



65. The velocity-time graph of a particle in one-dimensional motion is shown below. Which of the following formula are correct for describing the motion of the particle over the time interval from t_1 to t_2?



(a) $x(t_2) = x(t_1) + v(t_1)\,(t_2 - t_1) + \frac{1}{2}\,a\,(t_2 - t_1)^2$

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

(c) $a_{average} = [x(t_2) - x(t_1)]/(t_2 - t_1)$

(d) $a_{average} = [v(t_2) - v(t_1)]/(t_2 - t_1)$

(e) $x(t_2) = x(t_1) + v_{av}\,(t_2 - t_1) + \frac{1}{2}\,a_{av}\,(t_2 - t_1)^2$

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