PHYSICS

BOOKS - GK PUBLICATIONS PHYSICS (HINGLISH)

KINEMATICS

Illustrative Example

1. Road distance from Jaipur to Ajmer is 135km. How long can one afford to stop for lunch if

he can drive at an average speed of 72 kmph on the highway, if he has to reach in $2^{1/2} hr$

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2. A 10 hr tour is made at an average speed of 40 kph. Ifduring the first half of the distance the average speed of the bus was 30 kph, what was the average speed for the second half of the trip?

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3. A carrier train, when it is 100 km away from the station, going at a constant speedof 70 kph towards the station. At this instant a fast bird from its engine flies towards the station at 100 kph net speed.When the bird gets to the station, it turns back and flies again towards the train, when it reaches engine, it again turns and heads towards the station. If bird keep son flying in such a manner, find the distance travelled by the bird before train reaches the station ? How many trips, it made in this duration between station and the train ?

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4. An athlete starts running along a circular track of 50 m radius at a speed $5m/s$ in the clockwise direction for 40 s. Then the athlete reverses direction and runs inthe anticlockwise direction at 3 m/s for 100 s. At the end, how far around the track is the runner from the starting point ?

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5. A motorboat going downstream overcome a raft at a point A, $\tau = 60 \text{ min}$ later it turned back and after some time passed the raft at a distance $l = 6.0km$ from the point A. Find the flow velocity assuming the duty of the engine to be constant.

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6. Two ships, 1 and 2, move with constant velocities 3 m/s and 4 m/s along two mutually perpendicular straight tracks toward the intersection point O. At the moment $t = 0$ the ships were located at the distances 120 m and 200 m from the point O. How soon will the distance between the ships become the shortest and what is it equal to ?

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7. A particle at origin starts towards positive direction of x-axis, with an accelerationa. This acceleration can be defined in three ways,(a) $a =$ constant, (b) $a = f(x)$, and (c) $a = -f(t)$. Find the velocity of the particle as a function of time. Also find velocity of the particle when it is at a displacement x from origin. Given that the velocity of the particle at $t = 0$ is $v = w$.

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8. A driver travelling at 90 kph applied the brakes for 5 s. If the braking acceleration was $2m/s^2$, what was her final speed ?

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9. A slowly moving flat car is 12.0 m long passing apoint at straight road at 10 kph. A boy beside the road near to that point tosses rocks onto the moving flat car at the rate of one per second, (a) If the first rock just hits the front edge of the car, how many rocks will fall on to that car ? (b) How many rocks will fall onto that car if the car begins to accelerate at $0.5m/s^2$, just as the first rock hits the car ?

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10. In a car race, A takes a time of t s, less than car B at the finish and passes the finishing point with a velocity v more than car B. Assuming that the cars start from rest and travel with constant accelerations a_1 and a_2. Respectively, show that $v = \sqrt{a_1 a_2 t}$.

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11. Two bodies start moving in the same straight line at the same instant of time from the same origin. The first body moves with a constant velocity of $40ms^{-1}$, and the second starts from rest with a constant acceleration of $4ms^{-2}$.Find the time that elapses before the second catches the first body. Find the also the greatest distance between them prior to it and time at which this occurs.

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12. A driver travelling at 30 kph sees the light turn red at the intersection. If his reaction time is 0.6s , and the car can decelerate at $4.5m/s^2$, find the stopping distance ofthecar. What would the stopping distance be ifthe car were moving at 90 kph.

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13. If body travels half of its path in the last second of its fall from rest, find the time and height of its fall.

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14. A person sitting on the top of a tall building is dropping balls at regular intervals of one second. Find the positions of the 3rd, 4th and 5th ball when the 6th ball is being dropped.

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15. A small parachute dropped from a 30 m high cliff falls freely under gravity for 1.0 s and then attains a trminal velocity 1.2m/s. 20.0 s latera stone is dropped from the cliff. Will the stone catch up with the parachute before it reaches the ground ?

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16. A balloon is going up with a uniform speed 20 m/s. It was at a height of 100 m from ground, when a stone is dropped from its basket. Find the time taken by the stone to reach the groimd and the height of the balloon from the ground, when stone hits the ground. (Take $g = 10m / s^2$)

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17. From the foot of a tower 90m high, a stone is thrown up so as to reach the top of the tower. Two second later another stone is dropped from the top of the tower. Find when and where two stones meet (Take $g = 10m/s^2$)

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18. A girl is standing in an elevator that is moving upward at a velocity of $5m/s$ and acceleration $2m/s^2$, when she drops her handbag. If she was originally holding the bag at a height of 1.5 m above the elevator floor, how long will it take the bag to hit the floor

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19. A truck starts from rest with an acceleration of $1.5m/s^2$ car 150 m behind starts from rest with an acceleration of $2m/s^2$. How long will it take before both the truck and car side byside, and how much distance is traveled by each?

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20. An elevator car whose floor to ceiling distance is equal to $2.7m$ starts ascending with constant acceleration $1.2m/s^2$. 2 s after the start, a bolt begins falling from the ceiling of the car. Find

(a)the time after which bolt hits the floor of the elevator.

(b)the net displacement and distance travelled by the bolt, with respect to earth. (Take $g = 9.8m/s^2$)

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21. Consider the child standing on the top of a tower of height h, shown in figure-I .12. He throws the ball up and the ball follows the trajectory as shown in figure. Draw the displacement versus time graph of the ball's motion during its flight. Take vertically upwards direction as positive x-axis.

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22. Draw, the velocity - time graph for the case explained in example 1.21.

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23. A car starts moving rectilinearly first with acceleration $\alpha = 5ms^{-2}$ (the initial velocity is equal to zero), then uniformly, and finally, deceleration at the same rate α comes to a stop. The time of motion equals $t = 25s$. The average velocity during this time is equal to

$72kmh^{-1}$ How long does the car move uniformly?

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24. A car accelerates from rest at a constant rate α for some time after which it decelerates at a constant rate β to come to rest. If the total time lapse is t seconds , evauate.

(i) maximum velocity reached , and

(ii) the total distance travelled .

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25. Instantaneous velocity of a particle moving in astraight line is given as $v = (4 + 4\sqrt{t}) m / s$. For the first five second of motion. Then after velocity of it becomes a constant. Find the acceleration of the particle at time t = 3.0 s and its displacement till this instant.

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26. Instantaneous velocity of an object varies with time as $v = \alpha - \beta t^2$. Find its position and acceleration as a function of time, also find the object's maximum positive displacement from the origin.

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27. The velocity of a particle moving in the positive direction of the x axis varies as $v = \alpha\sqrt{x}$, where α is a positive constant.

Assuming that at the moment $t = 0$ the particle was located at the point $x = 0$, find:

(a) the time dependence of the velocity and the acceleration of the particle,

(b) the mean velocity of the particle averaged over the time that the particle takes to cover the first s metres of the path.

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28. A point moves rectilinearly with deceleration which depends on the velocity v of the particle as $a = k\sqrt{v}$, where is apositive constant. At the initial moments the velocity of the point is equal to v_0. What distance will it cover before it stops, and what time it will take to cover that distance.

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29. An object moves such that is acceleration is given as $a = 3 - 2t$. Find the initial speed of the object such that the particle will have the same x-coordinate at $t = 5.0$s as it had at

$t = 0$. Also find the object's velocity at $t = 5.0s$.

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30. A man standing on a road has to hold his umbrella at 30° with the vertical to keep the rain away. He throws the umbrella and starts running at 10km/hr. He finds that rain drop are hitting his head vertically. Find the speed of rain drops with respect to (a) road (b) the moving man.

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31. A $400m$ wide river is flowing at a rate of $2.0ms^{-1}$. A boat is sailing with a velocity of $10ms^{-1}$ with respect to the water, in a direction perpendicular to the river.

(a) Find the time taken by the boat to reach the opposite bank.

(b) How far from the point directly opposite to the starting point does the boat reach the opposite bank ?

(c) In what direction does the boat actually move ?

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32. Two trains, one travelling at 54 kph and the ot her at 72kph, are headed towards each ot her on a level track. When the yare two kilometers apart, both drivers simultaneously apply their brakes. If their brakes produces equal retardation in both the trains at a rate of $0.15 m / s^2$, determine whether there is a collision or not

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33. A boat moves relative to water with a velocity v which is n times less than the river flow velocity u. At what angle to the stream direction must the boat move to minimize drifting ?

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34. On morning Joy was walking on a grass-way in a garden.Wind was also blowing in the direction of his walking with speed u.He suddenly saw his friend Kim walking on the parallel grass-way at a distance x away.Both stopped as they saw each other when they were directly opposite on their ways at a distance x.Joy shouted "Hi Kim".Find the time after which Kim would have heard his greeting.Sound speed in still air is v.

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35. Two swimmers leave point A on the bank of the river to reach point B lying right across on the other bank. One of them crosses the river along the straight line AB while the other swims at right angles to the stream and then walks the distance that he has been carried away by the stream to get to point B. What was the velocity u of his walking if both swimmers reached the destination simultaneously? The stream velocity $v_0 = 2.0km\,/\,hour$ and the velocity v' of each swimmer with respect to water equals to $2.5km$ per hour.

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36. A particle is moving in XY plane such that its velocity in x-direction remains constant at $5m/s$ and its velocity in y-direction varies with time as $v = 3tm/s$, where t is time in seconds. Find :

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37. A car starts moving from rest on a horizontal ground such that the position vector of car with respect to its starting point is given as $\overrightarrow{r} = bt\hat{i} - ct^2\hat{j}$, where a and b are position constants, direction (x and y axes) intersect at the starting point of car (origin).

Find:

(a) The equation of the trajectory of car $y = f(x)$.

(b) The angle between direction of velocity and acceleration of car as a function of time $\theta = f(t)$.

(c) Average velocity of car over first t seconds of motion

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38. A point moves in the plane xy according to the law $x = at$, $y = at(1 - \alpha t)$, where a and α are positive constants, and t is time. Find:

(a) the equation of the point's trajectory $y(x)$, plot this function,

(b) the velocity v and the acceleration w of the point as functions of time,

(c) the moment t_0 at which the velocity vector forms an angle $\pi/4$ with the acceleration vector.

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39. A projectile is thrown from a point on ground with an initial speed u and at anelevatio θ to the horizontal. Find the change in momentum of the particle, when it reaches the top most point of its trajectory.

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40. When a particle is projected at an angle to the horizontal, it has range R and time of flight t_1. If the same projectile is projected with same speed at another angle to have the saem range, time of flight is t_2. Show that:

$t_1 t_2 = (2R/g)$

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41. Two second after projection, a projectile is travelling in a direction inclined at 30° to the horizontal. After one more second, it is travelling horizontally. Find the magnitude and direction of the velocity of projection.

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42. A cannon fires successively two shells from the same point with velocity $V_0 = 250 m / s$, the first at the angle $\theta_1 = 60^\circ$ and the second at the angle $\theta_2 = 45^\circ$ to the horizontal, the azimuth being the same. Neglecting the air drag, find the approximate time interval between firings leading to the collision of the shells $\left(g = 9.8m/s^2\right)$

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43. A particle is thrown over a triangle from one end of a horizontal base and after grazing the vertex falls on the other end of the base. If α and β be the base angles and θ the angle of projection, prove that $\tan\theta = \tan\alpha + \tan\beta$.

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44. A stone is projected from the ground in such a direction so as to hit a bird on the top of a telegraph post of height h and attains the maximum height of 2h above the ground. If at the insatant of projection, the bird were to fly away horizontally with a uniform speed, find the ratio between the horizontal velocity of bird and the horizontal component of velocity of stone, if the stone hits the bird while descending.

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45. The radius of the front and rear wheels of a carriage are a and b, and c is the distance between the front an drear axles. A particle of dust driven from the highest point of the rear wheel is observed to alight on the highest point of the front wheel. Find the velocity of the carriage.

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46. A ball starts falling with zero initial velocity on to a smooth inclined plane forming an angle α with the horizontal. Having fallen a distance h, the ball rebounds elastically off the inclined plane. At what distance from the impact point will the ball rebound for the second time ?

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47. A projectile is thrown at an angle θ with an inclined plane of inclination β as shown in fig. 1E108. Find the relation between β and θ ifv :

(a)projectile strikezs the inclined plane perpendicularly,

(b) projectile strikes the inclined plane horizontal.

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48. A child throws a ball so as to clear a wall of heigh than data distance x from it. Find the minimum speed required for clearing the wall.

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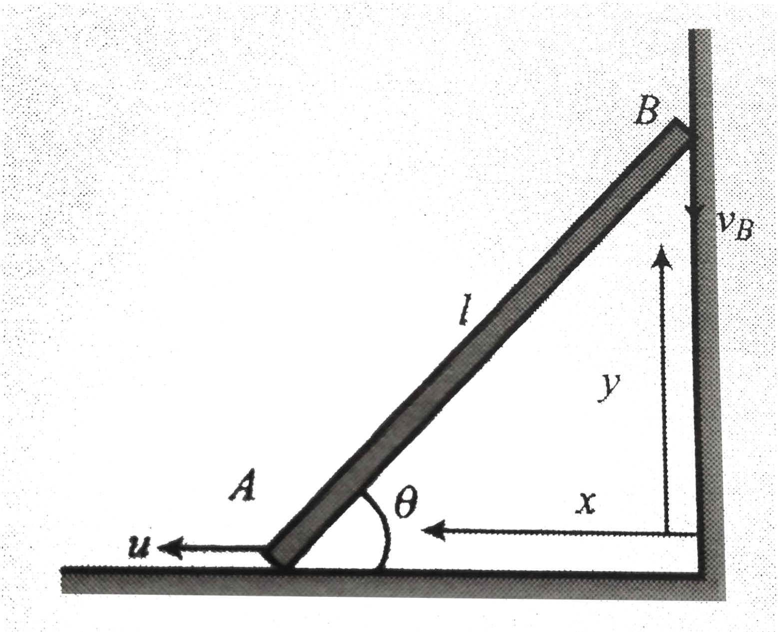
49. Figure shows a rod of length l resting on a wall and the floor. Its lower end A is pulled towards left with a constant velocity u. As a result of this, end A starts moving down along the wall. Find the velocity of the other end B downward when the rod makes an angle θ with the horizontal.



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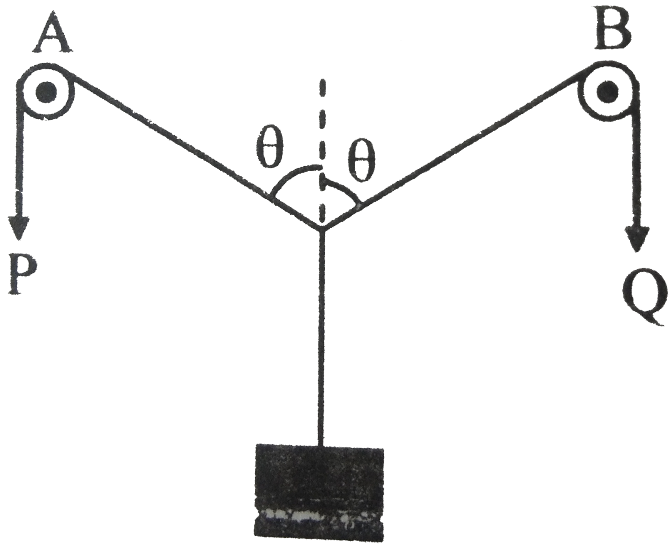
50. In the arrangement shown in fig the ends P and Q of an unstretchable string move downwards with unifrom speed U. Pulleys A and b are fixed. Mass M move upwards with a speed



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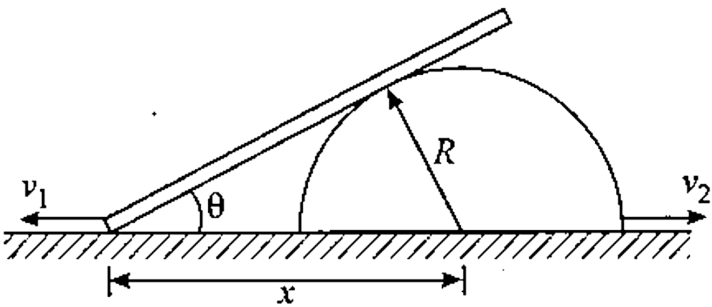
51. Figure-1.52 showns a hemisphere and a supported rod. Hemisphere is moving in right direction with a uniform velocity v_2 and the end of rod which is in contact with ground is moving in left direction with a velocity v_1. Find the rate at which the angle θ is changing in terms of v_1, v_2, R and θ.



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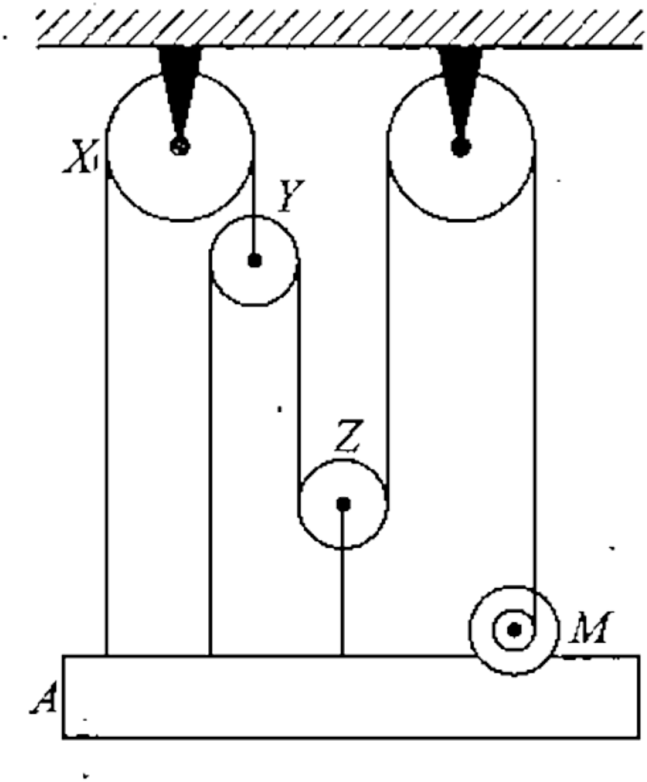
52. Consider the situation of block pulley arrangement shown in figure-1.63. A plank is connected to three strings and an electric motor M is fitted on to it and a string is wound on it according to the arrangement shown in figure. Given that the string is winding on shaft of motor at a speed v. Find the speed with which the plank would be going up.



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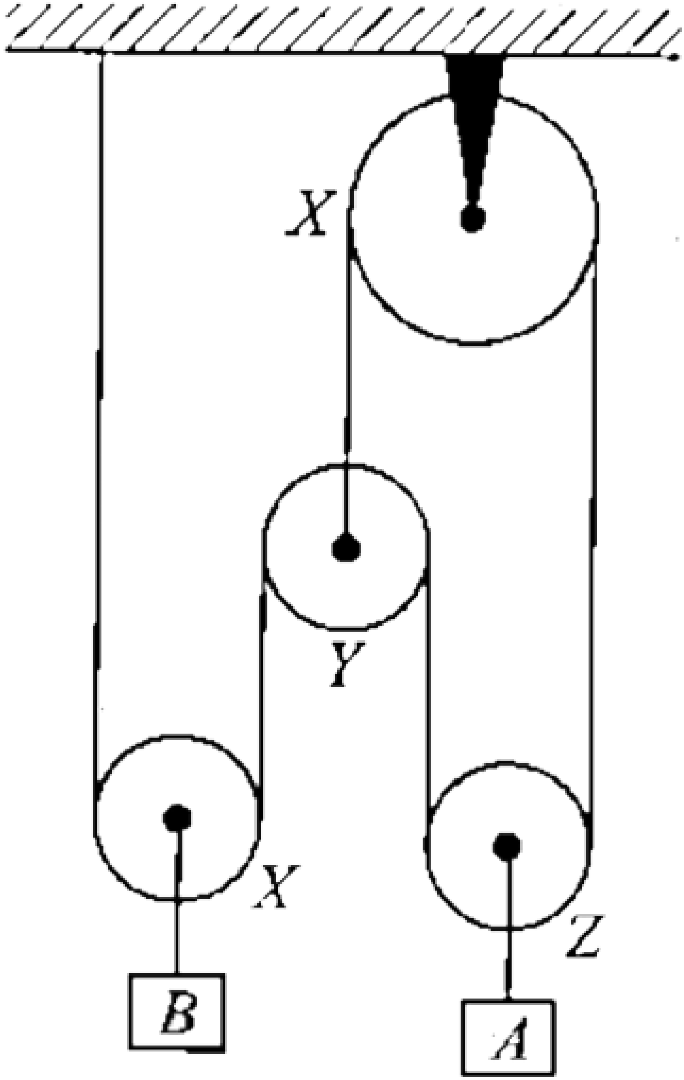
53. Figure-1.65 shows a system of four pulleys with two masses A and B. Find, at an instant:



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54. Consider the situation shown in figure-l.76 (a) Find the constraint relation for velocities of blocks A and B.

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55. Consider the situation shown in figure-1.77 (a). A string connected to block B is passing through two movable pulleys X and Yand wound on the smaller disc of a step pulley. Another block A attached to the pulley X. Analyze the constrained motion of blocks A and B. (Step pulley radii ratio $= 1:3$)

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56. If block B shown in figure-l.78(a) is going down with acceleration $5m/s^2$, find the acceleration of the block A. All pulleys and strings are ideal. Radii ratio for the two step pulleys are $1:3:5$ and $1:2$.

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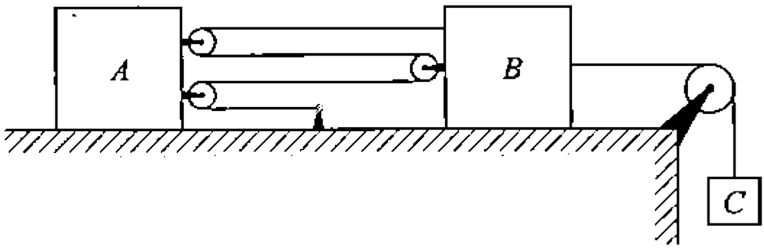
57. Block C shown in figure-1.79 is going down at acceleration $2m/s^2$. Find the acceleration of blocks A and B.



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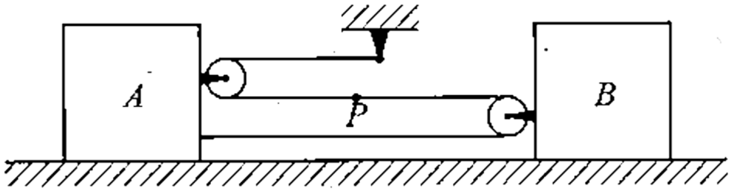
58. Blocks shown in figure-1.81 move by a distance 3 m toward left. Find the distance and direction in which the point P on string shown in figure is displaced.



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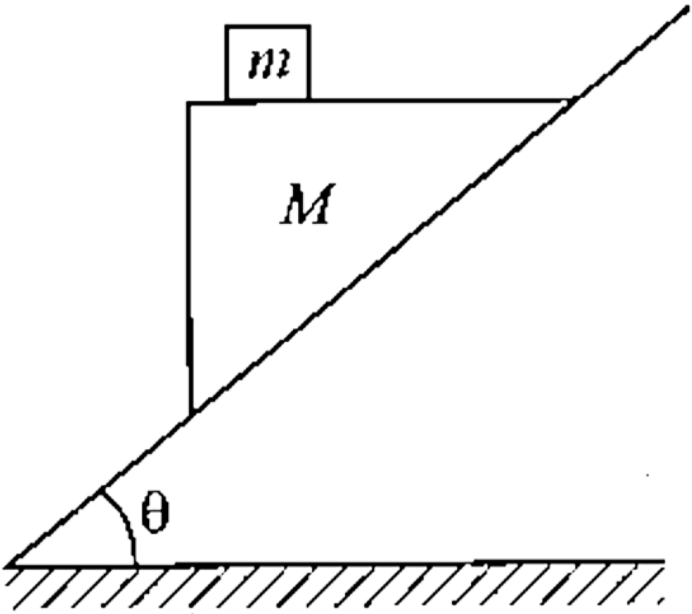
59. In the situation shown in figure-1.86, if mass M is going down along the incline at an acceleration of $5m/s^2$ and m is moving toward right relative to M horizontally with $3m/s^2$. Find the net acceleration of m



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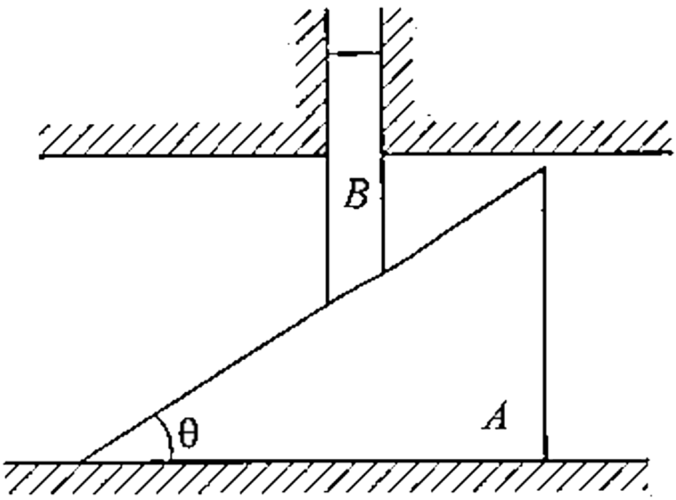
60. Find the relation among accelerations of wedge A and the rod B supported on wedge A. Rod B is restricted to move vertically by two fixed wall comers shown in figure-1.88.



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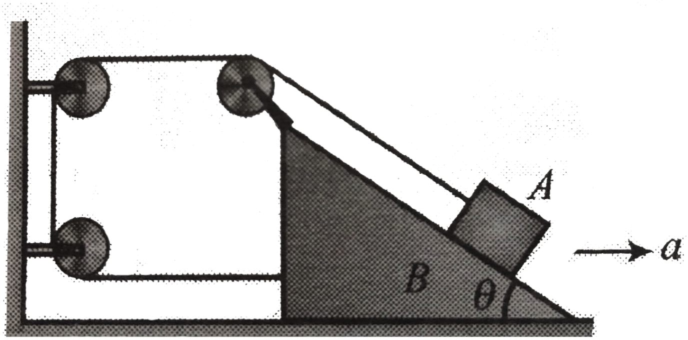
61. Figure shows a block A constrained to slide along the inclined plane of the wedge B shown. Block A is attached with a string which passes through three ideal pulleys and connected to the wedge B. If wedge is pulled toward right with an acceleration a, find

(a) the acceleration of the block with respect to wedge

(b) the acceleration of the block with respect to ground.



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Practice Exercise

1. Two bicycle riders made a 30 km trip in the sametime. Cyclist A travelled non-stop at an average speed of 20 kph. Another cyclist B travelled with a lunch break of 20 min. What was the average speed of B for the actual riding ?

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2. The light speed is $3.0 \times 10^{8} m / s$, and the sound speed is 340 m/s. Find the value of count N, if "A child start counting after every second, he sees a bomb blast 1km away and stops when he hear its 'blast sound."

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3. Two cars travelling in parallel lanes at 90 kph and 72 kph. Assuming each car to be 5 m long, find the time taken during the overtake and the total road distance used for the overtake

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4. A point traversed half of the total distance covered by its with velocity v_0.The remaining part of the distance was covered with velocity

v_1 for half of the remaining time, and with velocity v_2 for the other half of the remaining time.Find the mean velocity of the point over the whole time of motion.

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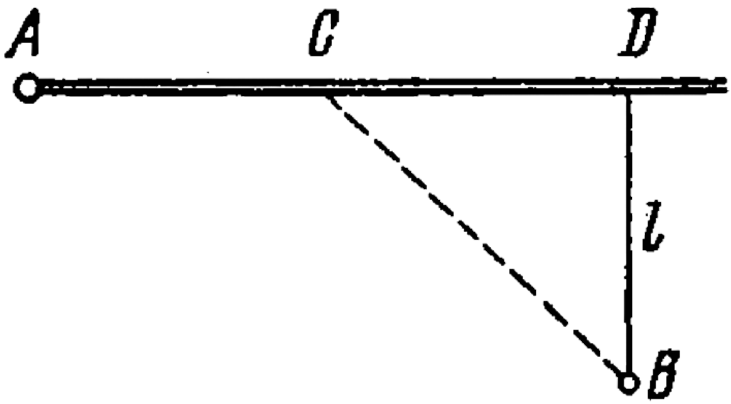
5. From point A located on a highway (figure) one has to get by car as soon as possible to point B located in the field at a distance l from the highway. It is known that the car moves in the field η times slower than on the highway.

At what distance from point D one must turn off the highway?



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6. Two junglemen are standing at the two opposite banks of a river of width l facing each other. One of the m starts beating a drum and sound reaches to the other one after time t_1 the stats. Then second one starts beating the drum and now first one hear the sound after time t_2. Calculate the velocity of sound relative to air and the velocity of wind, if it is blowing from first bank to the other bank at right angle to the river flow

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7. A rectangular farm house has a $1km$ difference between its sides. Two farmers simultaneously leave one of the vertex of the rectangle for a point at the opposite vertex. One farmer crosses the farmhouse along its diagonal and other walks along the edge. The speed of each farmer is $4km/hr$. If one of them arrives half an hour earlier then the other then the size of farmhouse is .

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8. A car is moving at a constant speed of 40 km/h along a straight road which heads towards a large vertical wall and makes a sharp 90^0 turn by the side of the wall. A fly flyingat constant speed of 100 km/h, starts from the wall towrds the car t an instant when the car is 20 km away,flies until it reaches the glasspane of the car and returns to teh wll at teh same speed. It continues to fly between the car and teh wall time the car makes the 90^0 turn. a. What is the total distance the fly has travelled during the period?b. How many trips has it made between the car and the wall?

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9. A bike starts from rest and accelerates at $4m/s^2$ for 5.0 s. It then moves at contant velocity for 25.0s, and then decelerates at $2.0m/s^2$ unit it stops. Find the total distance that the motorcycle has moved.

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10. Fiate Siena can accelerate from 0 to 48 kph in 3.6s and from 0 to 96 kph in 10.2 s Also, under constant acceleration from rest it crosses the 0.4 km marker at as peed of 140 kph. (a)Calculate the average acceleration needed get the speed 48 kph. (b) Calculatethe average acceleration during the time it requires to go from 48 to 96 kph. (c) What constant acceleration would be required to get a speed of 140 kph over the 0.4 km run starting from rest ?

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11. Two friends start bikes from one corner of as quarefield of edge L towards the diagonally opposite corner in the same time t: They both start from the same place and take different routes. One travels along the diagonal with constant acceleration a, and the other accelerates momentarily and then travels along the edge of the field with constant speed v. What is the relationship between a and v ?

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12. A truck travelling along a straight road at a constant speed of 72 kph passes a car at time $t=0$ moving much slower. At the instant the truck passes the car, the car starts accelerating at constant $1m/s^2$ and overtake the truck 0.6 km further down the road, from where the car moves uniformly. Find the distance between them at time $t=50s$.

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13. A motorcycle and a car start from rest from the same place at the same and travel in the same direction. The motorcycle acceleration at $1.0ms^{-1}$ up to a speed of $36kmh^{-1}$ and the car at $0.5ms^{-1}$ up to a speed of $54kmh^{-1}$. The time at which the car would overtake the motorcycle is

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14. A driver having a definite reaction time is capable of stopping his car over a distance of

30 m on seeing a red traffic signal, when the speed of the car is 72 km/hr andover a distance of 10 m when the speed is 36 km/hr. Find the distance over which he can stop the car if it were running at a speed of 54 km/hr. Assume that his reaction time and the deceleration of the car remains same in all the three cases.

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15. A point moving with constant acceleration from A to B in the straight line AB has velocities u and v at and B respectively. Find its velocity at C, the mid point of AB. Also show that if the time from A to C is twice that from C to B, then $v = 7u$.

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16. A train is targeted to run from Delhi to Pune at an average speed of 80 kph but due to repairs of track looses 2hr sin the first part of the journey. If then accelerates at a rate of $20kph^2$ till the speed reaches 100 kph. Its speed is now maintained till the end ofthe journey. If the train now reaches station in time, find the distance from when it started accelerating ?

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17. A train of length $l = 350m$ starts moving rectilinearly with constant acceleration

$w = 3.0 \cdot 10^{-2} m / s^2$, $t = 30s$ after the start the locomotive headlight is switched on (event 1), and $\tau = 60s$ after that event the tail signal light is switched on (event 2). Find the distance between these events in the reference frames fixed to be train and to the Earth. How and at what constant velocity V relative to the Earth must a certain reference frame K move for the two events to occur in it at the same point?

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18. Two cars travelling towards each other on a straight road at velocity $10m/s$ and $12m/s$ respectively. When they are 150 metre apart, both drivers apply their brakes and each car decelerates at $2m/s^2$ until it stops. How far apart will they be when they have both come to a stop?

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19. Two bodies start moving in the same straight line at the same instant of time from the same origin. The first body moves with a constant velocity of $40ms^{-1}$, and the second starts from rest with a constant acceleration of $4ms^{-2}$.Find the time that elapses before the second catches the first body. Find the also the greatest distance between them prior to it and time at which this occurs.

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20. A ball is allowed to slip from restdown a smooth incline plane, and the distances are

marked every 2.0 s. If the second mark is made 1.6 m from the starting point, where are the first and fourth marks ?

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21. Water drops from the nozzle of a shower into the stall floor 176.4 m below. The drops fall at regular interval of time, the first drop striking the floor at the instant the fourth drop begins to fall. Find the location of the individual drops when a drop strikes the floor.

Take $g = 9.8m/s^2$

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22. A particle is projected vertically upward from the ground at time $t = 0$ and reaches a height h at $t = T$. Show that the greater height of the particle is $\left(gT^2 + 2h\right)^2 / 8gT^2$

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23. A circus artist maintains four balls in motion making each in turn to rise to a height of 5 m from hishand. Calculate the velocity with which he projects the balls. Where will the other three balls be at the instant when the fourth one is just leaving his hand ? Take $g = 10m/s^2$

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24. A dog sees a flowerpot sail upand then back down past a window 5 ft high. If the total time the pot is in sight is 1.0 sec, find the height above the window that the pot rises. Take $g = 32ft/s^2$

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25. A ball projected vetically upwards from (A), the top of tower reaches the ground in t_1 second.

If it is projected vectically downwards from (A) with the same vecoty, it reaches the ground in t_2 seconds .

If it falls freely from (A), show that it would reahc the ground in $\sqrt{t}_1 t_2 = 2 \sec onds$.

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26. Jimmy is doing an experiment to measure the height of a tall building. He drops awatermelon from the roof the building. 3.0 s later he hears the watermelon splash sound.

What height of the building he had calculated. Take speed of soimd 340 m/s and air resistance, on water melon can be neglected. Take $g = 10m/s^2$

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27. You are on the roof of your school building 60m, high. You see your physics teacher 1.6 m tall walking directly towards the building at 2.m/s. You wish to throw an egg vertically down at a speed 5m/s on to your teacher's head. Where should your teacher be when you throw the egg. Neglect air resistance. Take $g = 10m/s^2$

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28. A student goes to the a 100 m high floor of Kutubmeenar at Delhi. To verify the law of gravity, he starts from a window with zero initial velocity, with a stop watch in his hand. After 3.0 s, Batman comes to the same floor and jumps to save the boy. What must be his initial velocity so that he'll just be able to save the boy. Assume free fall for both boy and Batman before he catches the boy. Take $g = 10m / s^2$

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29. From the top of at all building (height27.3m), a boy throws an apple upward, which strikes ground after 16 s. Take $g = 9.8m / s^2$, find the speed of apple with which it was thrown and the maxium height reached by it.

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30. A roket fired vertically ascends with a constant acceleration $g/3$ for 1 min. Its fuel is then all used and it continues to rise as a free body. What is the maximum height reached? What is the total time elapsed from the take off until the rocket strikes the earth?

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31. A truck driver, starting with zero speed at time zero, drove in such a way that the speed time graph is approximately an isosceles triangle with the base along the time axis. The maximum speed was $30m/s$, and the total elapsed time was 50.0 s. What distance did he travel.

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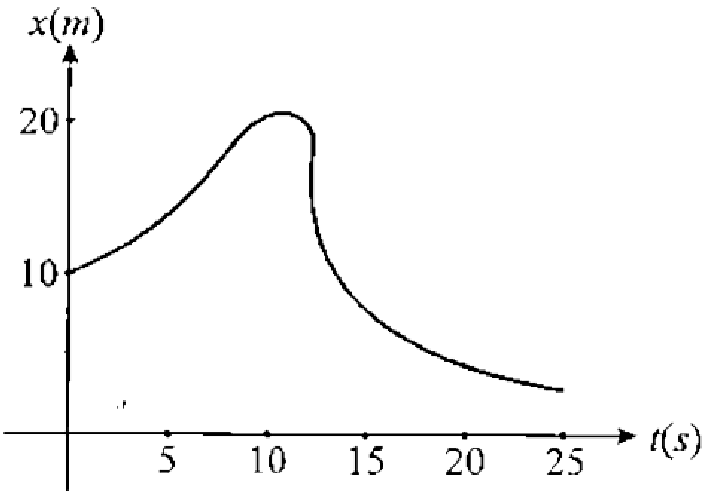
32. Figure-1.20 shows displacement-time graphof a particle. Find the time during motion such that the average velocity of the particle during that period is zero.



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33. A train starts from station A with uniform acceleration a_1. For some distance and then goes with uniform retardation a_2 for some more distance to come to rest at station B. The distance between stations A and B is $4km$ and the train takes $1/5h$ to compete this journey. If accelerations are in km per minute unit, then show that $\frac{1}{a_1}+\frac{1}{a_2}=x$. Find the value of x.

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34. Between two stations a train starting from rest first accelerates uniformly, then moves with constant velocity and finally retarts uniformly to come to rest. If the ratio of the time taken be $1:8:1$ and the maximum speed attained be $60km/h$, then what is the average speed over the whole journey ?

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35. A partical starts from rest and moves in a straight line. It travels a distance L with uniform acceleration and then moves with constant velocity a further distance $2L$. Finally, it comes to rest after moving a further distance 4L under uniform retardation. Find the ratio of average speed to the maximum speed.

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36. A particle starts with an initial velocity u towards $+x$ direction with an acceleration a after time t_1, it starts retarding with another acceleraation a', comes to an instantaneous stop and returns. If reaches its initial position at time t_2. Draw the approximate time dependence plots for particle's displacement and velocity.

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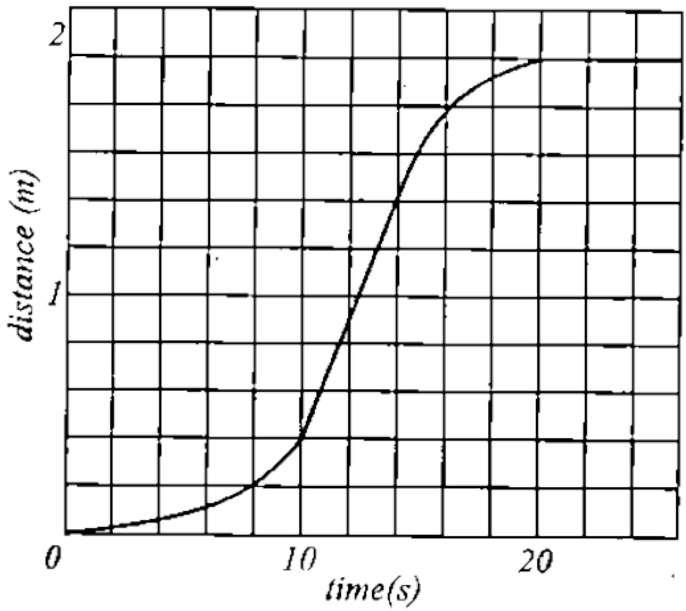
37. A particle moves in a straight line. Figure-1.21 shows the distance traversed by the particle as a function of time t.Using the graph, find (a)the average velocity of the point during the time of motion, (b) the maximum velocity, (c) the time $t = t_0$ at which the instantaneous velocity is equal to the mean velocity averaged over the first t_0 seconds.



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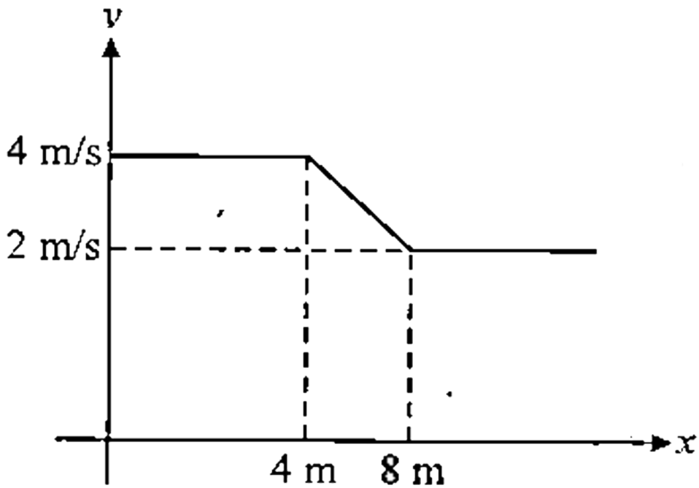
38. The velocityof a particle that moves in the positive X- direction varies with its position, as shown in figure-1.22. Find its acceleration in m/s^2 where $x = 6m$



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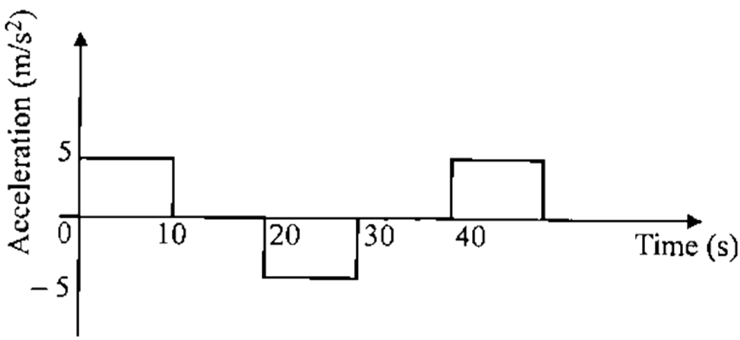
39. The acceleration vs time of a particle moving along $+x$ direction is shown in figure-1.23. If starts at $t=0$, from rest, Draw the position -time graph for the motion.



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40. The displacement x of particle moving in one dimension, under the action of a constant force is related to the time t by the equation

$t = \sqrt{x} + 3$

where $x is \in meters$ and $t \in \sec onds$. Find

(i) The displacement of the particle when its velocity is zero , and

(ii) The work done by the force in the first $6 \sec onds.$

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41. Instantaneous velocity of a particle moving in $+x$ direction is given as $v = \frac{3}{x^2 + 2}$. At $t = 0$, particle starts from origin. Find the average velocity of the particle between the two points $p(x = 2)$ and $Q(x = 4)$ of its motion path.

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42. A street car moves rectilinearly from station A to the next station B (from rest to rest) with an acceleration varying according to the law $f = a - bx$, where a and b are constants and x is the distance from station A. The distance between the two stations and the maximum velocity are

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43. A particle moves along a staight line such that its displacement at any time t is given by $s = t^3 - 6t^2 + 3t + 4m$. Find the velocity when the acceleration is 0.

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44. A radius vector of a particle varies with time t as $r = at(1 - \alpha t)$, where a is a constant vector and α is a positive factor. Find:

(a) the velocity v and the acceleration w of the particles as functions of time,

(b) the time interval Δt taken by the particle to return to the initial points, and the distance s covered during that time.

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45. A box is thrown with velocity v_0 on top of a rough table of length l. Assume friction on the object is such that during its motion, its acceleration is given as $a = -kv$, where k is a positive constant. Find the velocity of the box when it leaves the edge of the table. Also find the time after which it falls off the edge.

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46. A particle start revolution with initial speed u in a circular path of radius R. During

revolution it is retarded due to friction and its acceleration is given as $a = cv^2$. Find the speed of the particle after completing one revolution.

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47. A rever $500m$ wide flows at a rate at a rate of $4kmh^{-1}$. A swinmmer who can swin at $8kmh^{-1}$. In still water, wishes to cross the river straight . (i) Along what direection must he strike? (ii) What should be his resultant velocity. (ii) What is the time of crossing the river?

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48. An aeroplane takes off from Mumbai to Delhi with velocity 50 kph in north-east direction. Wind is blowing at 25 kph from north to south. What is the resultant displacement of aeroplane in 2 hrs.

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49. A man can swim at a speed of 3 km/h in still water. He wants t cross a 500 m wide river flowing at 2 km/h. He flow while swimming. A. Find the time he takes to cross the river. b.At what point on the opposite bank will he arrive?

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50. Two boats, A and B, move away from a buoy anchored at the middle of a river along the mutually perpendicular straight lines: the boat

A along the river, and the boat B across the river. Having moved off an equal distance from the buoy the boats returned. Find the ratio of times of motion of boats τ_A / τ_B if the velocity of each boat with respect to water is $\eta = 1.2$ times greater than the stream velocity.

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51. A man running on the horizontal road at $8 km h^{-1}$ find the rain appears to be falling vertically. He incresases his speed to $12 km h^{-1}$

and find that the drops make angle 30^2 with the vertical. Fin dthe speed and direction of the rain with respedt to the road.

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52. Two trains A and B are approaching each other on a straight track, the former with a uniform velocity of 25 m/s and other with 15m/s, when they are 225 m a part brakes are simultaneously applied to both of them. The deceleration given by the brakes to thetrain B increases linearly with time by $0.3m/s^2$ every second, while the train A is given a uniform deceleration, (a) What must be the minimum deceleration of the train A so that the trains do not collide ? (b) What is the time taken by the trains to come to stop ?

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53. A body starts from rest at A and moves with uniform acceleration in a straight line. T seconds after,a second body starts from A and moves with uniform velocity Kinthe same line. Prove that the second body will be ahead of the first for a time $\frac{2}{a}\sqrt{V(V-2aT)}$

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54. An aeroplane has to go from a point A to another point B, $500km$ away due 30° east of north. Wind is blowing due north at a speed of $20m/s$. The steering-speed of the plane is $150m/s$. (a) Find the direction in which the pilot should head the plane to reach the point

B. (b) Find the time taken by the plane to go fram A to B.

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55. Find the time an aeroplane having velocity v takes to fly around a square with side a if the wind is blowing at a velocity u along one side of the square.\

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56. A man swimming in a river from a point. A on one bank has to reach a point C on other bank, which is at a distance l from the point B, directly opposite to A on other bank. River width is d and the current velocity is u_0. Find the minimum speed of swimmer relative to still water with which he should swim.

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57. The coordinates of a bird flying in the xy-plane are $x = 2 - \alpha t$ and $y = \beta t^2$, where $\alpha = 3.6m/s$ and $\beta = 1.8m/s^2$. Calculate 'the velocity and acceleration vectors and their magnitude as a functions of time .Also find the magnitude and direction of bird's velocity and acceleration at $t = 3.0s$. From the given data can you find whether at this instant, bird is speeding up, speeding down or it is taking a turn. If so in which direction

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58. On a smooth horizontal platform a mass of 2 kg is dragged with a horizontal force of 10 Nt. On platform there are so many holes spreaded on its surface below which there is an air blower which exerts a force on block in upward direction depending on its height above the platformas $\vec{F} = 20(2 - h)N$, where h is the height of the block above the platform. Let at $t = 0$ block starts from rest from origin of coordinate system shown. Find the equation of trajectory of the block during its motion. Consider x-axis along the motion ofparticle and y-axis in vertical up direction.

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59. A ball is thrown straight up in air with an initial velocity u. Air exerts a force on it in horizontal direction which produces an acceleration depending on its height from ground as $a_x = ah^2$. Find the displacement of ball from the projection point as a function of time.

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60. A boy releases a toy plane from the top of a high hill of height H. Hill is so high that gravity varies with height from ground as $g = g_0\left(1 - \frac{2h}{R}\right)$, where h is the height from ground and R is the radius of earth. The engine of toy plane accelerates it in horizontal direction with acceleration $a_x = bt^2$. Find the position from the foot of hill where the plane lands and the time after which it lands.

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61. The position vector of a particle P with respect to a stationary point O change with time according to the law $\overrightarrow{r} = \overrightarrow{b} \sin \omega t + \overrightarrow{c} \cos \omega t$ where $\overrightarrow{b}$ and $\overrightarrow{c}$ are constant vectors with $bpotc$ and ω is a positive constant. Find the equation of the path of the particle $y = f(x)$, assuming x an dy axes to coincide with the direction of the vector $\overrightarrow{b}$ and $\overrightarrow{c}$ respectively and to have the origin at the point O

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62. The motion of a particle restricted to move in a two dimensional plane is given by

$x = 2\cos \pi t$

and $y = 1 - 4\cos 2\pi t$

where x and y are in metres and t is in seconds. Show that the path of the particle is a part of parabola $y = 5 - 2x^2$. Find the velcoity and the acceleration of particle at $t = 0$ and $t = 1.5s$.

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63. A stone is thrown from the top of a tower of height 50 m with a velocity of 30 m per second at an angle of 30° above the horizontal. Find (a) the time during which the stone will be in air, (b) the distance from the tower base to where the stone will hit the ground, (c) the speed with which the stone will hit the ground, (d) the angle formed by the trajectory of the stone with the horizontal at the point of hit.

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64. A stone is thrown up from the top of a tower 20,m with a velocity of 24m/s a tan elevation of 30° above the horizontal. Find the horizontal distance from the foot of the tower to the point at which the stone hits the ground. Take $g = 10m/s^2$

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65. Two bodies are thrown at the same time and in opposite directions and with an equal

velocity v_0 at angles α_1 and α_2 to the horizon. What is the velocity with which the bodies move relative to each other -? What will be the distance between the bodies be after time t elapses ?

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66. A ball rolls off top of a staircase with a horizontal velocity ums^{-1}. If the steps are h metre high and b mere wide, the ball will just hit the edge of nth step. Find the value of n.

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67. A boat is moving directly away from a gun on the shore with speed v_1. The gun fires a shell with speed v_2 at anangle of elevation α and hits the boat. Prove that the distance of the boat from the gun at the moment it is fired is given by:

$$\frac{2v_2 \sin\alpha}{g}(v_2 \cos\alpha - v_1)$$

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68. Two bodies were thrown simultaneously from the same point, one, straight up, and the other, at an angle of $\theta = 60^\circ$ to the horizontal. The initial velocity of each body is equal to $v_0 = 25m/s$. Neglecting the air drag, find the distance between the bodies $t = 1.70s$ later.

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69. Two particles are projected from a point at the same instant with velocities whose horizontal and vertical components are u_1, v_1 and u_2, v_2 respectively. Prove that the interval between their passing through the other common point of their path is

$$\frac{2(v_1u_2 - v_2u_1)}{g(u_1 + u_2)}$$

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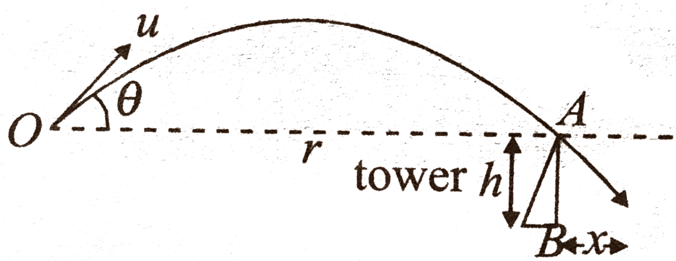
70. A ball is thrown from a point in level with velocity u and at a horizontal distance r from the top os a tower of height h.

How must the speed and angle of the projection of the ball be related to r in order that the ball may just go grazing the top edge of the tower ?



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71. In a "RamLeela"stage show an unhappy guy from audience throws an rotten egg at Rawana. The egg travels a horizontal distance of 15 m in 0.75 s before hitting the Rawana's face 1.7 m above the stage. The egg is thrown at 2.0 m above the horizonta floor with an initial velocity 30° above the horizontal, (a)Find the initial and final velocities of egg. (b)How high is the stage above the floor. Take $g = 10m/s^2$

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72. A machine gun is mounted on the top of a tower of height h=100 m. At what angle should the gun be inclined to cover a maximum range of firing on the ground below ?The muzzle speed of the bullet is $u = 150 ms^{-1}$ and $g = 10 ms^{-2}$.

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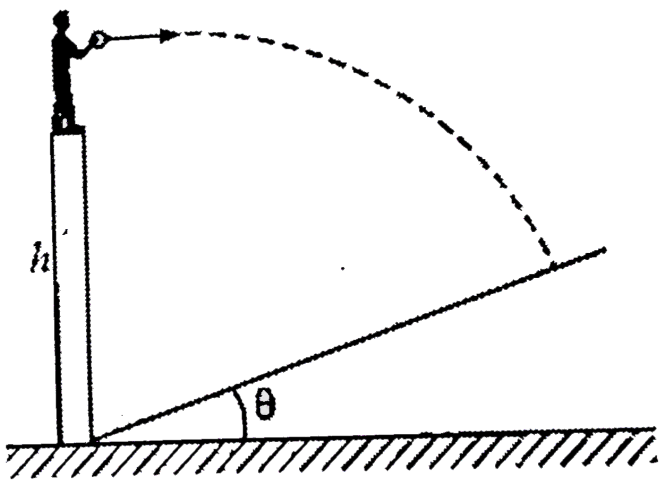
73. A partacle is thrown in horizontal direction with speed u from a point P, the top of a tower shown in figure.1.49 at a vertical height h above the inclined plane of inclination θ. Find the speed with which the particle is thrown so that it strikes the plane normally. Also find the distance from the foot of the tower where the particle will strike.



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74. From an inclined plane a particleis thrown in a direction normal to the surface. Find the ratio of successive ranges of the particle on inclined plane. Consider all collisions as elastic collisions (particle rebounds with the same speed with which it strikes the plane)

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75. A body is projected up with a speed v_0 along the line of greatest slope of an inclined plane of angle of inclination β. If the body collides elastically perpendicular to the inclined plane, find the time after which the body passes through its point of projection.

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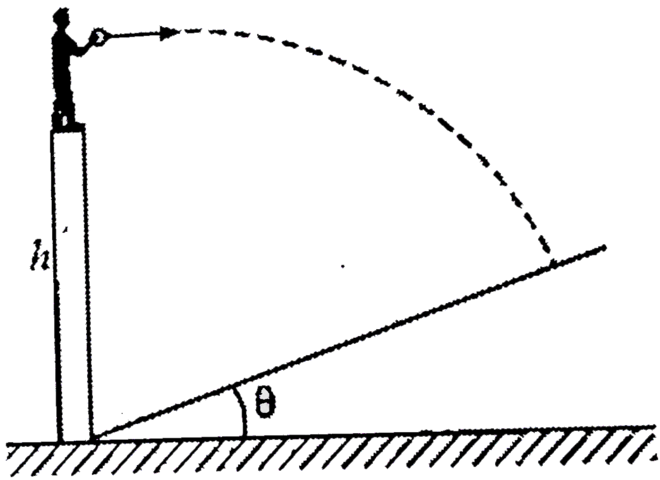
76. A partacle is thrown in horizontal direction with speed u from a point P, the top of a tower shown in figure.1.49 at a vertical height h above the inclined plane of inclination θ. Find the speed with which the particle is thrown so that it strikes the plane normally. Also find the distance from the foot of the tower where the particle will strike.



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77. In example 1.49 find the velocity of the mid point of the rod in terms of its length l, v and θ.

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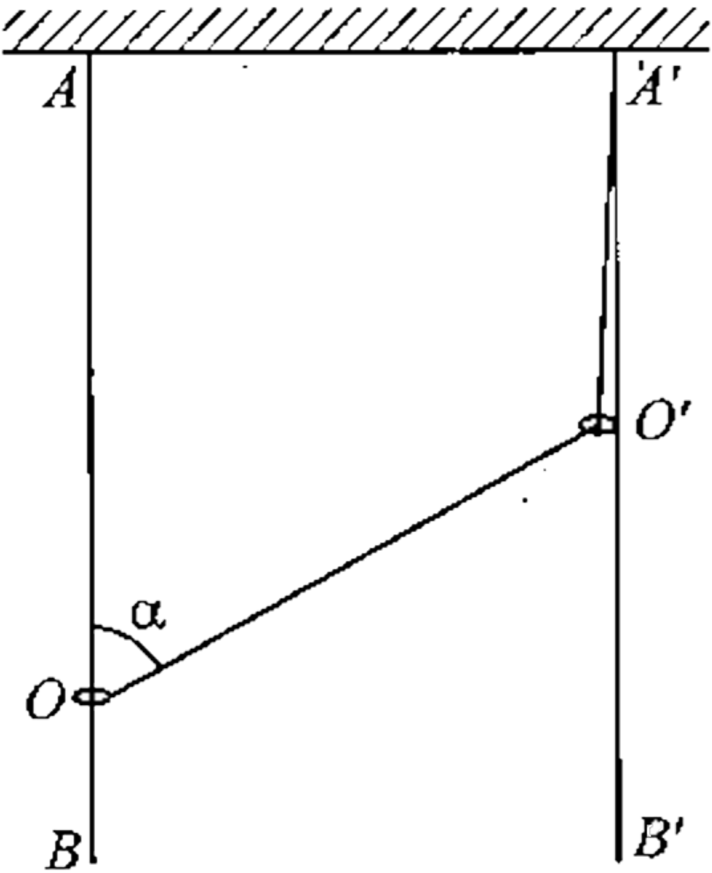
78. Two rings O and O' are put on two vertical stationary rods AB and A'B' respectively as shown in figure. An inextensible string is fixed at point A' and on ring O and is passed through O' moves downwards at a constant speed v, find the velocity of the ring O in terms of α.



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79. An aircraft is descending to land at an airport in the morning. The aircraft is landing to the east, so that pilot has the sun in his eyes. The aircraft has a speed v and is descending at an angle α and the sun is at an angle β above the horizon. Find the speed with which the aircraft's shadow moves over the groung.

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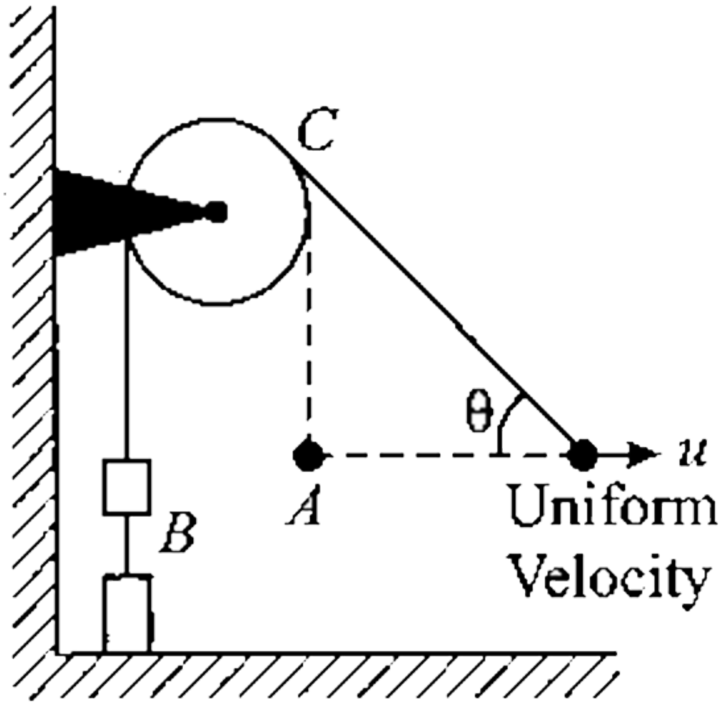
80. Figure shows s small mass m hanging over a pulley. The other end of the thread is being pulled in horizontal direction with a uniform speed u. Find the speed with which the mass ascend at the instant the string makes an angle θ with the horizontal.



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81. A man of height 1.2 m walks away from a lamp hanging at a height of 4.0 m above ground level. If the man walks with a speed of $2.8m/s$, determine the speed of the tip of man's shadow.

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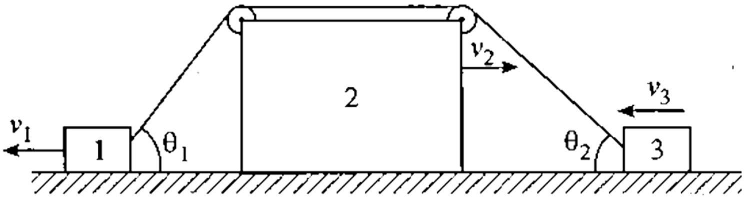
82. Find the speed of the box-3, if box-1 and box-2 are moving with speeds v_1 and v_2 as shown in figure when the string makes an angle θ_1 and θ_2 with the horizontal at its left and right end.



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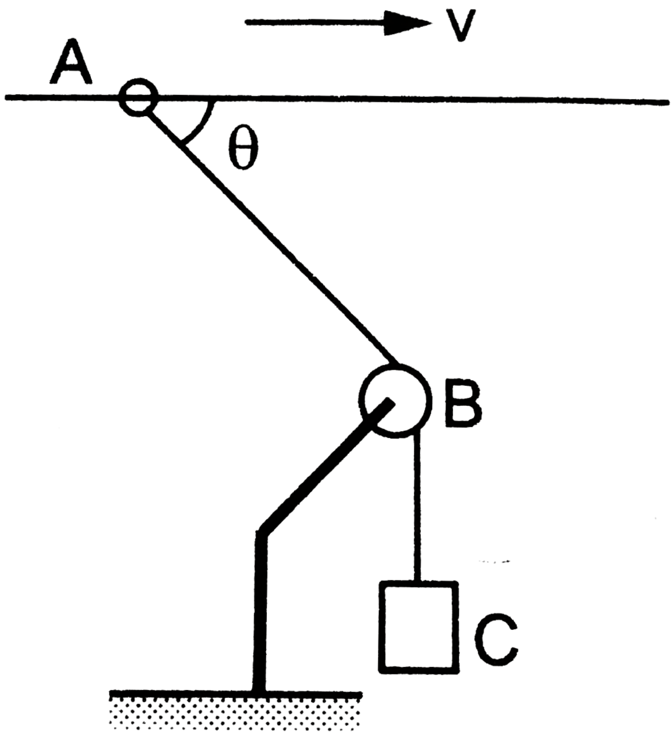
83. A smooth ring A of mass m can slide on a fixed horizontal rod. A string tied to the ring passes over a fixed pulley B and carries a block C of mass $M(=2m)$ as shown in figure. At an instant the string between the ring and the pulley makes an angle θ with the rod. (a). Show that, if the ring slides with a speed v, the block descends with speed $v\cos\theta$, (b). With what acceleration will the ring starts moving if the system is released from rest with $\theta = 30^0$



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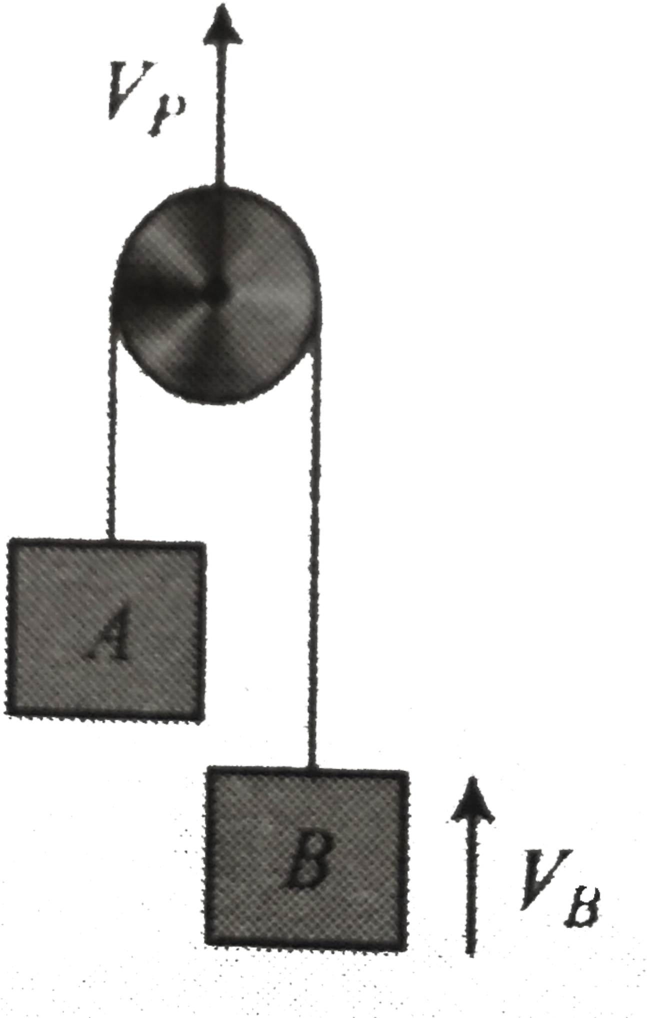
84. Figure shows a pulley over which is string passes and connected to two masses A and B. Pulley moves up with a velocity V_P and mass B is also going up at a velocity V_B.



Find the velocity of mass A if

(a) $V_P = 5ms^{-1}$ and $V_B = 10ms^{-1}$

(b) $V_P = 5ms^{-1}$ and $V_B = -20ms_{-1}$.

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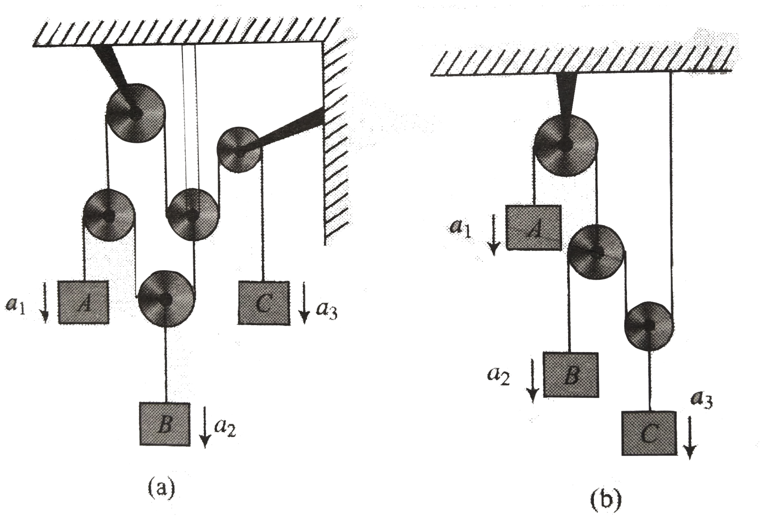
85. Find the relation in the accelerations of the three masses shown in fig.



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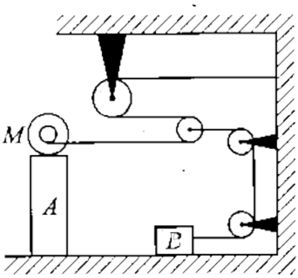
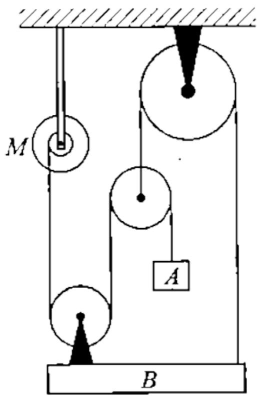
86. Figure (a) and (b) shows a system of two masses A and B a motor M. find the relation in velocities of mass A and B, if the motor winding speed is v.



(a)



(b)

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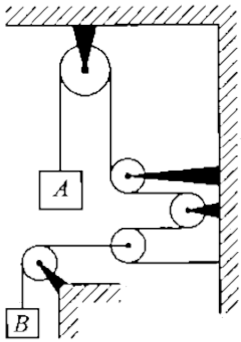
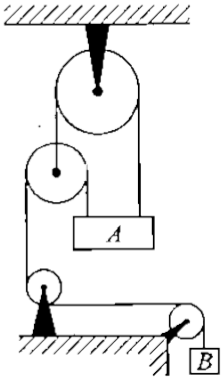
87. Find the Relation among velocities of the blocks shown in figure (a), (b) moving under the given constraints.



(a)



(b)

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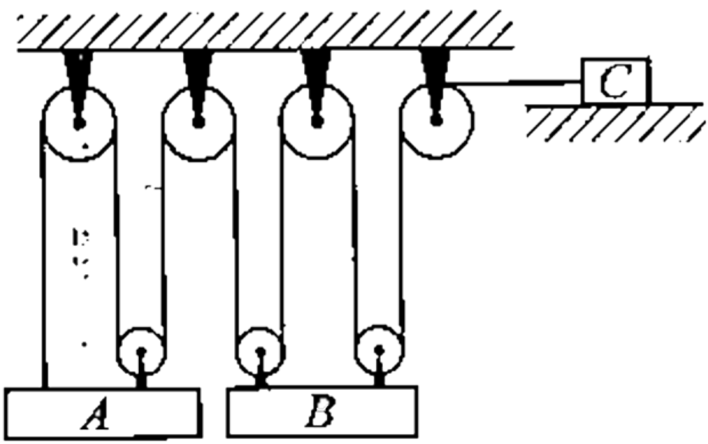
88. Block B shown in figure , moves downwards with a constant velocity of $20cm/s$. At t = 0, block A is moving upward with a constant acceleration, and its velocity is $3cm/s$. If at $t = 3s$ blocks C has moved 27 cm to the right, determine the velocity of block C at t = 0 and the acceleration of A and C.



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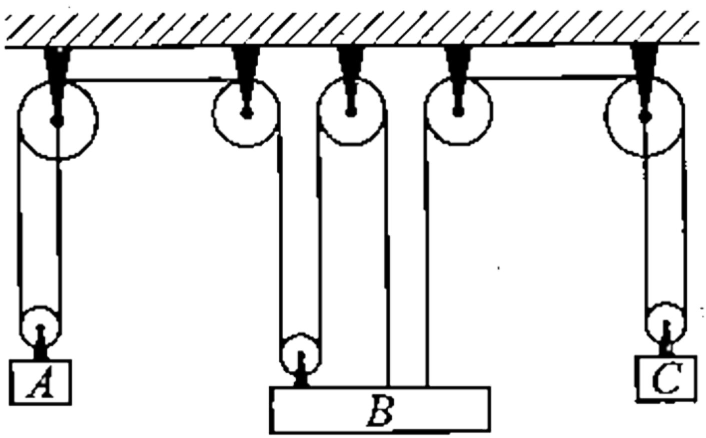
89. Block C shown in figure, starts from rest and moves downward with a constant acceleration. Knowing that after 12s the velocity of block A 7.2 m/s, determine the acceleration of A, B and C and the velocity and the displacement of block B after 8s.



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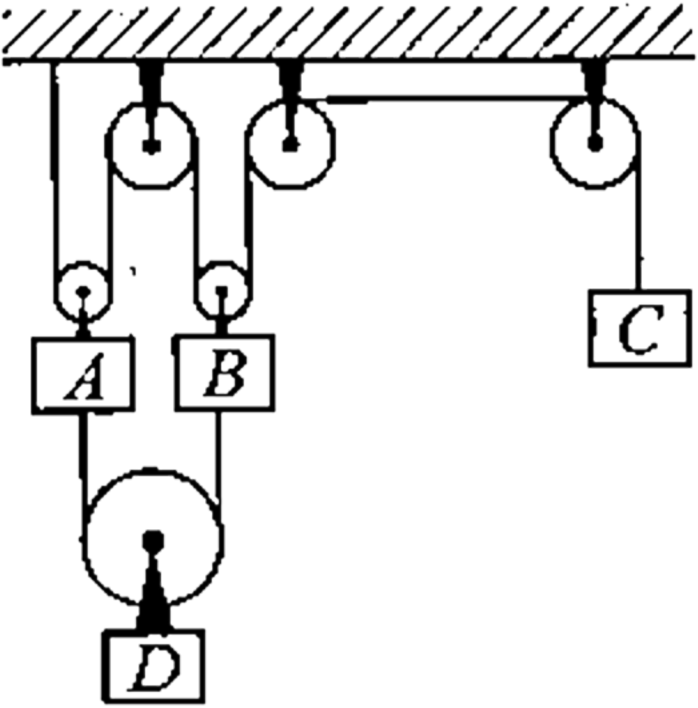
90. The system shown in figure starts from rest, and each block moves with a constant acceleration. If the relative acceleration of block C with respect to block B is $6m/s^2$ upward and the relative acceleration of block

D with respect to block C after 3s from starts.



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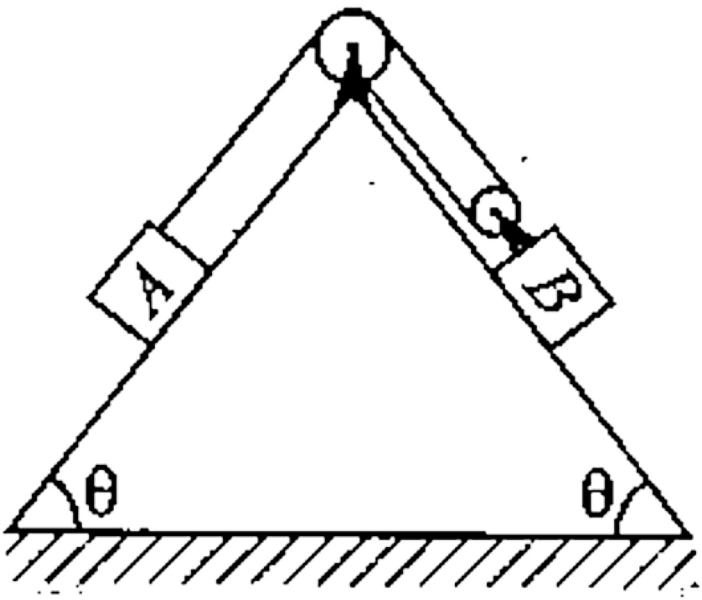
91. Find the relation among the acceleration of blocks A and B constrained to move along the inclined surfaces of the fixed wedge shown in figure



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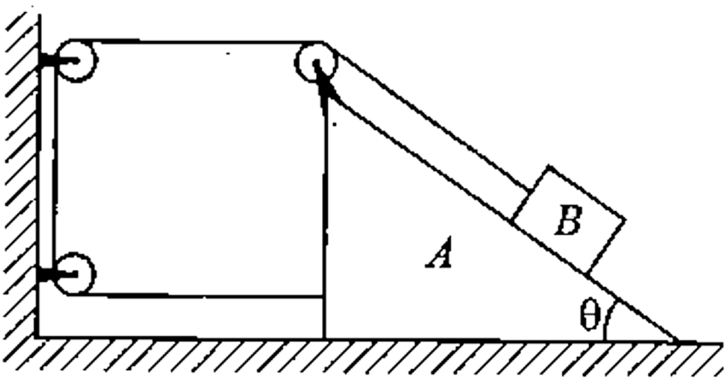
92. If the wedge A shown in figure-1.93, is moving toward left with acceleration $3\frac{m}{s^2}$, find the net acceleration of block B which is constrainedtoslide along the wedge surface. $(\theta = 30^\circ)$



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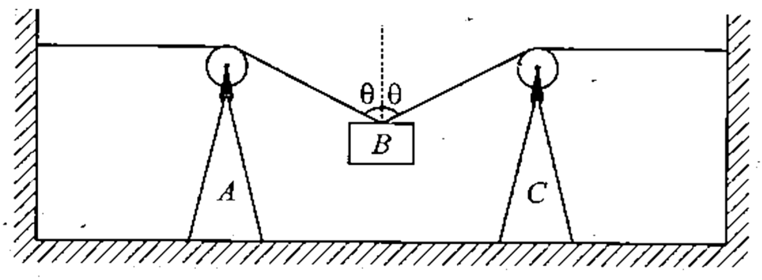
93. Find the speed of the block B when the wedges A and C are moving toward each other with speed v and the strings connected to block make and angle θ with the vertical, as shown in figure



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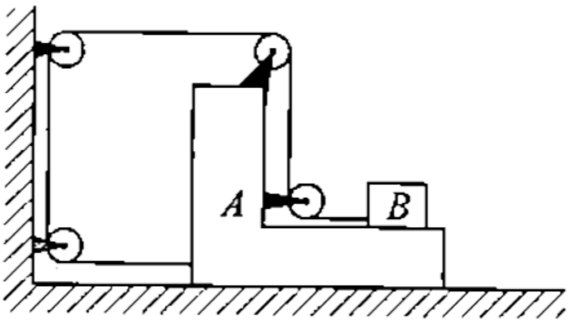
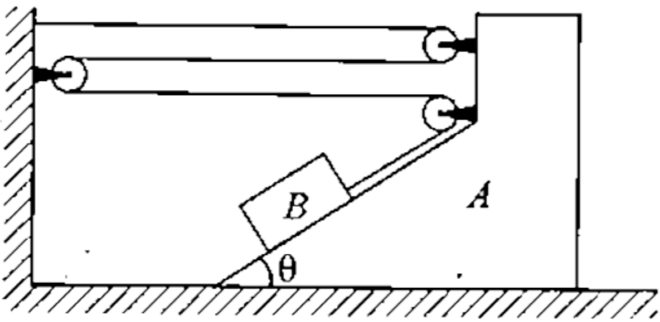
94. Find the acceleration of the block B as shown in figure- 1.95 (a) and (b) relative to the block A and relative to ground if the block A is moving toward left with acceleration a.



(a)



(b)

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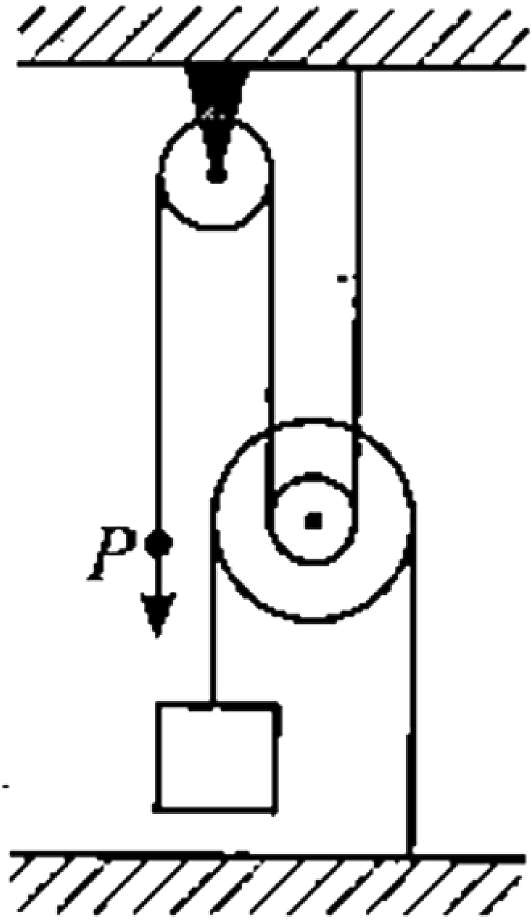
95. If the point P on string shown in figure-1.96 is pulled down with a velocity v, find the velocity of the block A connected to another string passing over a step pulley with radii ratio $1:2$.



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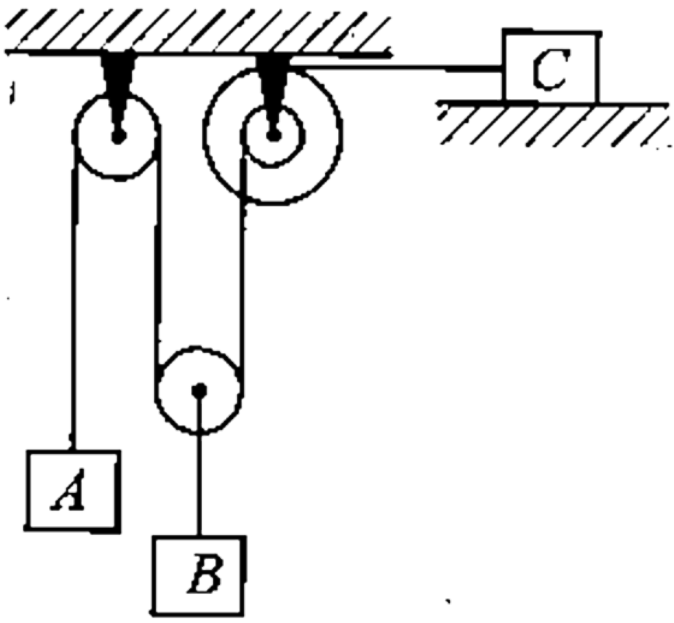
96. Find the constrained relation among the acceleration of blocks A, B and C for the situation shown in figure-1.97. Ratio of radii of step pulley is given as $1:2$.



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Discussion Question

1. Give an example of a case in which an object's velocity is zero but its acceleration is not. Can an object's velocity ever be in a direction other than the direction of its acceleration? Explain.

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2. Sketch graphs of velocity and acceleration as a function of time for a car as it strikes a telegraphic pole. Repeat for a billiard ball in a head on collision with the edge of the billiard table.

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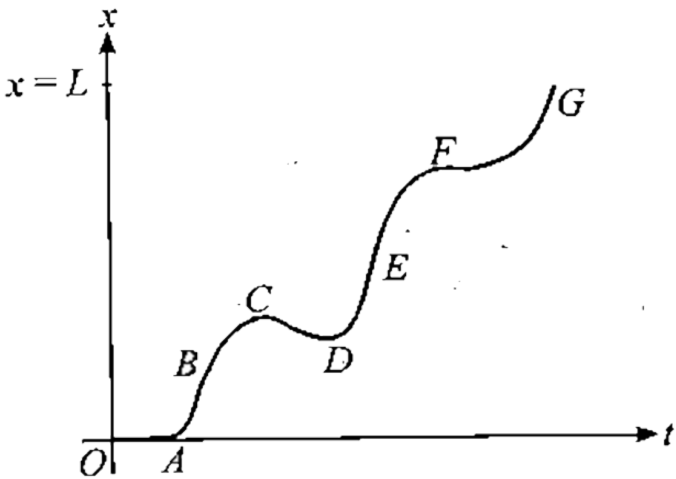
3. A rabbit enters the end of a drainpipe of length L. Its motion from that instant is shown in figure-1.98. Describethe motion in words.



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4. Under what conditionit is wrong to say that an object's acceleration is negative when the object is thrown upward. Does the sign of the acceleration depend at all on the direction. Can an object's acceleration be positive when the object is slowing down ?

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5. The distance-time curve for a hypothetical journey has the shape of an equilateral triangle with one side along the time axis. Discuss the velocity and acceleration necessary to bring about such a journey. Comment on whether or not this is a realistic journey. Will it be a real curve if it is a displacement-time curve.

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6. If you want to hit a distant stationary object with arifle, you have to adjust the aiming hole pipe for the mark of corresponding approximate distance. What is the need for it. Why don't you use a single adjustment for firing objects at different distances

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7. A man standing on the edge of a cliff throws a stone straight up with initial speed (u) and then throws another stone straight down with same initial speed and from the same position. Find the ratio of the speeds. The stones would have attained when they hit ground at the base of the cliff.

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8. A helicopter on a flood relief mission flying horizontally with a speed u at an altitude h, has to drop a food packet for a victim standing on the ground. At what distance form the victim should the food packet be dropped.

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9. A car's speedometer is correctly calibrated for tires of a specific size. If larger diameter tires are substituted, what will be the effect on the speedometer reading ?

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10. If an observer is in a boat accelerating with a constant acceleration, observes a stone dropped from rest from the top of a mast. What would be the path of the stone observed. What would be the path if stone had been thrown down ward from the top of the mast rather than dropped from rest.

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11. Each second a rabbit moves half the remaining distance from its nose to ahead of lettuce. Does the rabbit ever get to the lettuce ? What is the limiting value of the rabbit's velocity? Draw graphs showing the rabbit's position and average velocity versus time.

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12. Assume that a car is moving behind a loaded truck. Both moving with the same uniform velocity. A box from the top of the truck falls. Does car hit the box before the box hits the road, if driver neither brake nor accelerate ?

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13. A second ball is dropped down from an elevator acceleration up with $1m/s^2$, 1 second after the first ball is dropped. How does the relative velocity of the two balls change with time. How the ratio v_1 / v_2 change with time.

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14. Assertion : In javelin throw, the athlete throws the projectile at an angle slightly more than 45°.

Reason : The maximum range does not depends upon angle of projection.

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15. A foot ball is thrown in a parabolic path. Is there a point at which the acceleration is parallel to the velocity ?Perpendicular to the velocity ? Explain.

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16. If a rabbit can give it self the same initial speed regardless of the direction in which it jumps, how is the maximum vertical height to which it can jump related to it smaximum horizontal range ?

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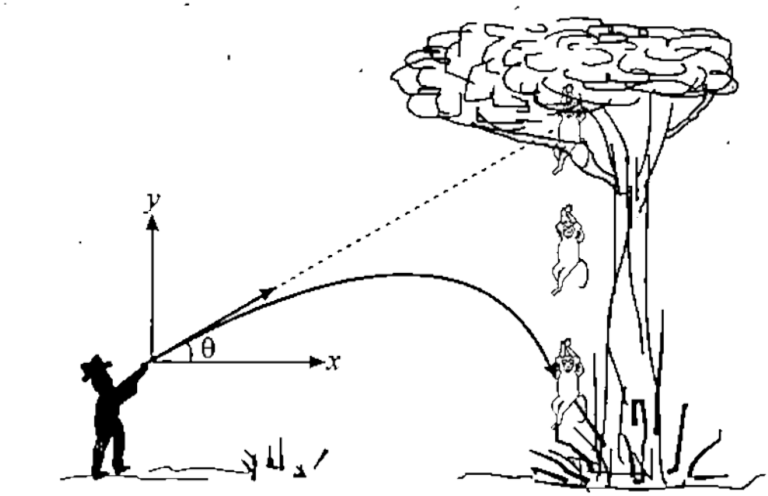
17. Look at the situation shown in figure-1.99. A fire man fires his shot aiming to a monkey, who fall sat the time of shot. So the shot has passed the highest point of it strajectory and is descending when it hits the monkey, which is still in air. At the instant, the shot was at the highest point of its trajectory,was them on key's height above the ground the same, lower, or higher than that of the shot. Explain your answer.



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18. If you are on the west bank of a river that is flowing north with a speed 4m/s. Your swimming speed relative to the water is 5 m/s, and the river is 60m wide. What is your path relative to earth that allows you to cross the river in the shortest time? Explain your reasoning.

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Conceptual Mcqs Single Option Correct

1. For a particle moving along a straight line, the displacement x depends on time t as $x = At^3 + Bt^2 + Ct + D$. The ratio of its initial velocity to its initial acceleration depends on:

A. A & C

B. B & C

C. C

D. C and D

Answer: B

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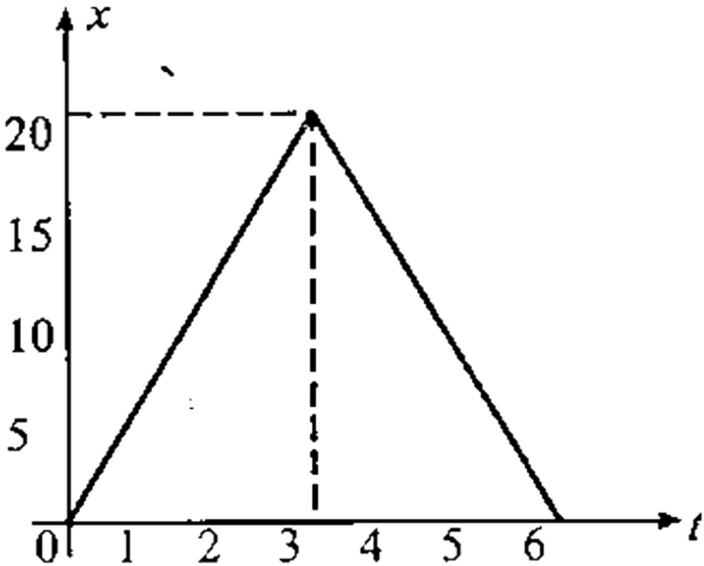
2. For the displacement time graph shown in figure -1.100, the ratio of the speeds during the first two seconds and the next four second is :



A. $1:1$

B. $1:2$

C. $2:1$

D. $3:2$

Answer: A

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3. From the top of a tower, a stone A is thrown upwards and a stone B is thrown downwards with the same speed. The velocity of stone A, on colliding with the ground is :

A. Greater than the velocity of B

B. Less than the velocity of B

C. The velocities of stones A and B will be same

D. Both the stones will fall on the earth at the same time

Answer: C

Watch Video Solution

4. Two cars C_1 and C_2 are moving on parallel roads in the same direction with velocity v. The relative of C_1 w.r.t. C_2 is :

A. Direction towards C_2

B. Direction towards C_1

C. Zero

D. 2v

Answer: C

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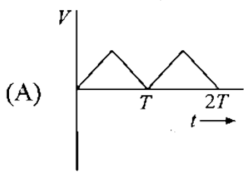
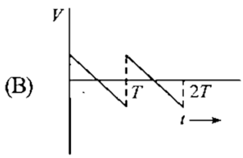
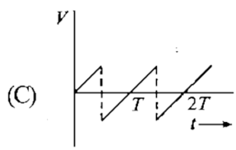
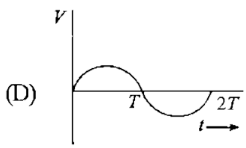
5. A ball dropped from a height reaches the same height after elastic impact with a glass floor. If the event is continued, the velocity-time graph is shown by the adjoining figure :

A. 

B. 

C. 

D. 

Answer: C

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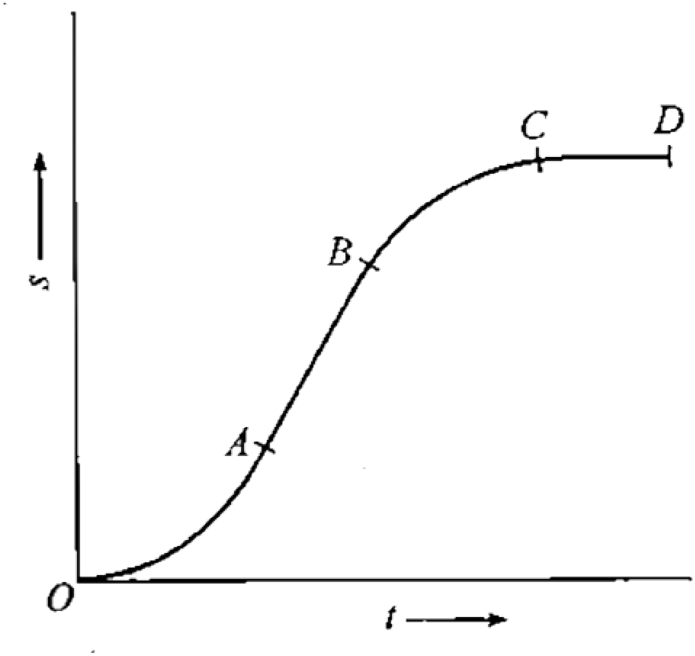
6. The distance-time curve of a moving motor-car is according to the following figure-1.101.

The portion OA of the curve shows:



A. Accelerated motion

B. Retarted motion

C. Uniform motion

D. State of rest

Answer: A

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7. In the above figure, the portion AB of the curve shows:

A. Accelerated motion

B. Retarted motion

C. Uniform motion

D. State of rest

Answer: C

Watch Video Solution

8. In the above figure, the portion BC of the curve shows:

A. Accelerated motion

B. Retarted motion

C. Uniform motion

D. State of rest

Answer: B

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9. Two particles start from rest simultaneously and are equally accelerated throughout the motion, the relative velocity ofone with respect to other is :

A. Zero

B. Non zero and directed parallel to acceleration

C. Non zero and directed opposite to acceleration

D. Directed perpendicular to the acceleration

Answer: A

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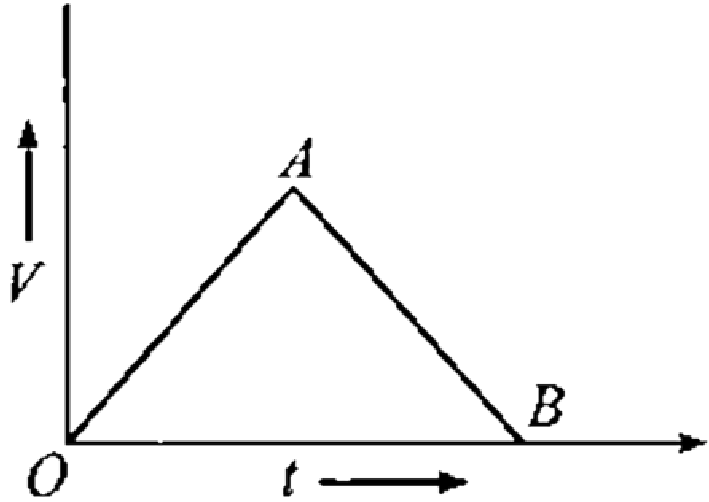
10. The following graph shows the speed ofabody which is :



A. Projected upwards with some velocity in vertical plane

B. Having only constant accelerated motion

C. Having only the constant retardation

D. A perfectly elastic ball falling from a height on a fnction less and hard floor

Answer: D

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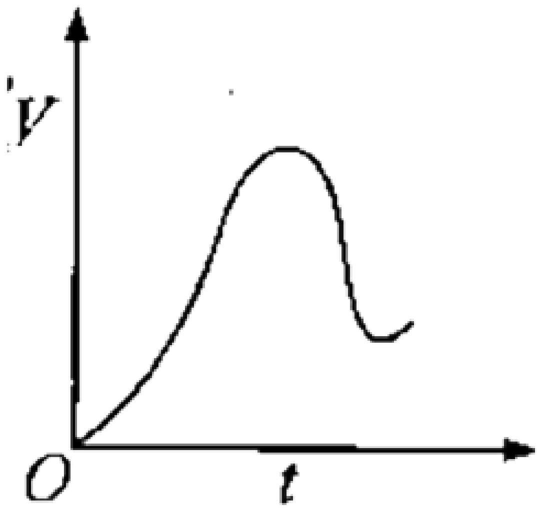
11. The following figures show some velocity versus time curves. But only some of these can be realised in practice. These are:

(a) 

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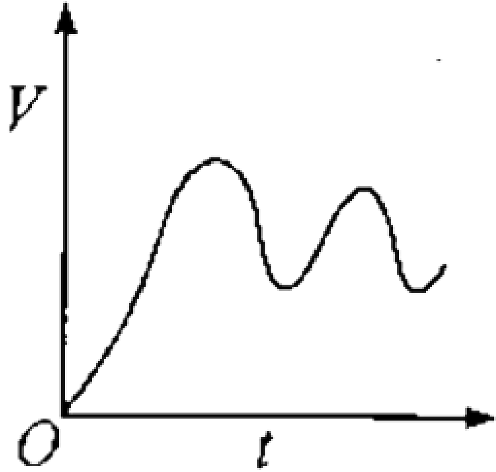
(b)



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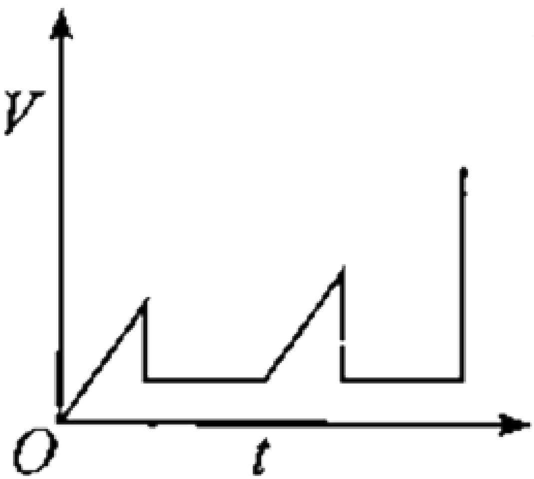
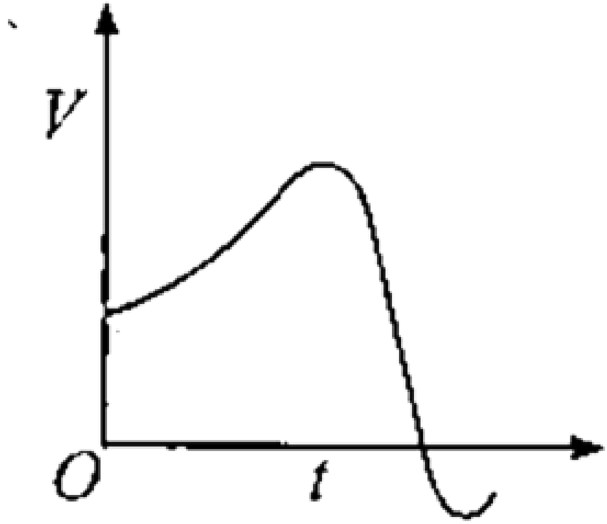
(c)



,

(d)



A. Only a, b and d

B. Only a, b, c

C. Only b and c

D. All of them

Answer: A

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12. The distance travelled by the moving body is :

A. The area between the speed time graph and time axis.

B. The area between the speed time graph and speed axis

C. The area between the distance time graph and time axis

D. The area between the distance time graph and distance axis

Answer: A

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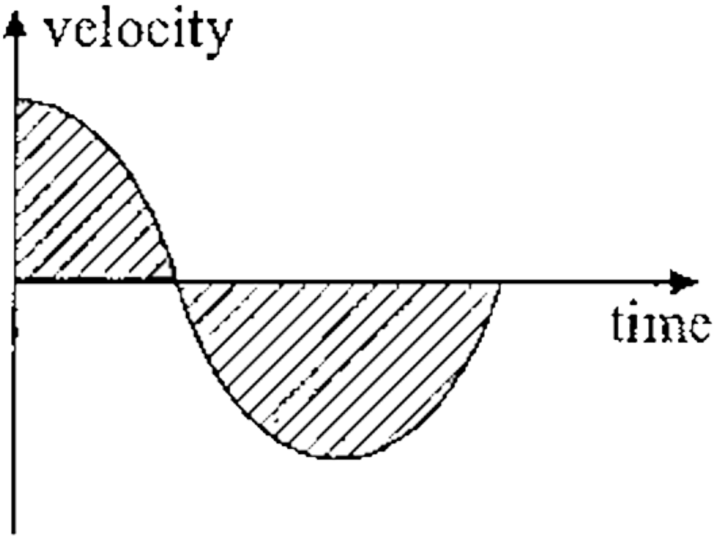
13. The diagram shows the velocity-time graph for a particle moving in a straight line. The sum of the two shaded areas represents :



A. The increase in displacement of the particle

B. The average velocity of the particle

C. The average acceleration ofthe particle

D. The distance moved by the particle

Answer: D

Watch Video Solution

14. Forces proportional to AB, BC & 2 CA act along the sides of triangle ABC in order, their resultant represented in magnitude and direction as:

A. CA

B. AC

C. BC

D. CB

Answer: A

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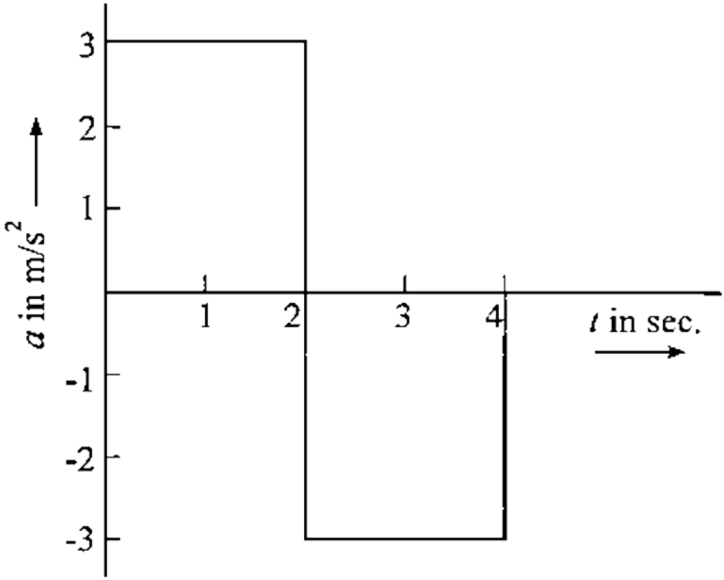
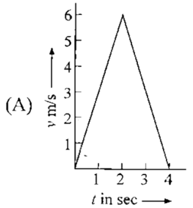
15. A particle moves as shown in the following figure 1.104:

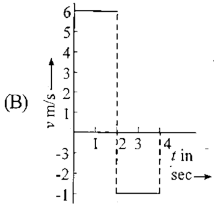


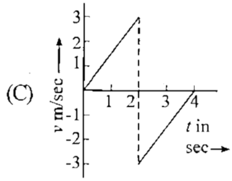
From the above curve the correct velocity-time graph for the interval of 4 seconds will be :

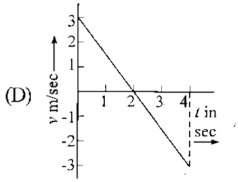
A.



B.



C. 

D. 

Answer: A

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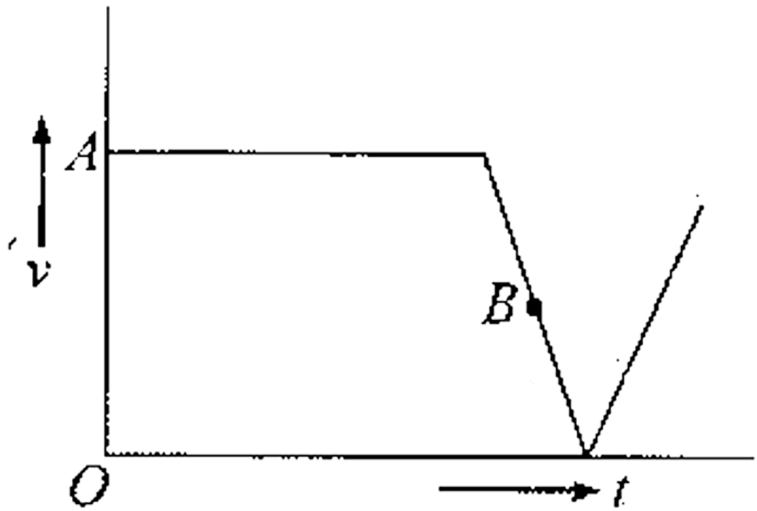
16. The following figure-1.105 shows the velocity-time graph ofa body. According to this, at the point B:



A. The force is zero

B. The force is in the direction of the motion

C. The force is in opposite direction of the motion

D. It is only the gravitational force

Answer: C

Watch Video Solution

17. A bullet is fired in a horizontal direction from a tower while a stone is simultaneously dropped from the same point then :

A. The bullet and the stone will reach the ground simultaneously

B. The stone will reach earlier

C. The bullet will reach earlier

D. None of these

Answer: A

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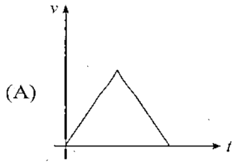
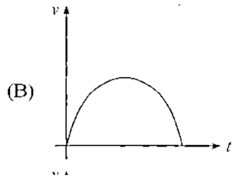
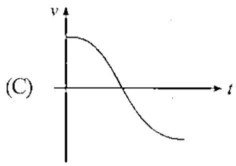
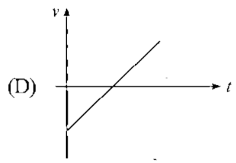
18. Which graph in the following figure best represents the variation of velocity with time of a ball which bounces vertically on a hard surface, from the moment when it rebounds from the surface ?

A. 

B. 

C. 

D. 

Answer: D

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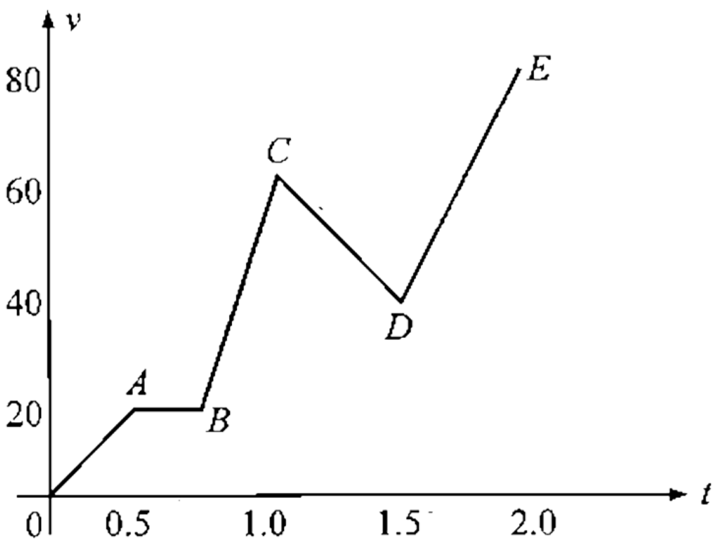
19. The variation in the speed of a car during its two hour journey is shown in the graph of the figure-1.106. The magnitude of the maximum acceleration of the car occupies an interval of:



A. OA

B. BC

C. CD

D. DE

Answer: B

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20. A car which has front and rear glass screens almost vertical is moving on a road when rain drops' are falling vertically downward. The rain will strike:

A. The front screen only

B. The rear screen only

C. Both the screens

D. The particular screen depending upon the velocity

Answer: A

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21. A river is flowing from north to south at a speed of 0.3 kph. A man on the west bank of the river, capable of swimming 1 kph in still water, wants to swim across the river in the shortest time. He should in a direction:

A. Due east

B. 30° north of east

C. 30° weat of north

D. 60° north of east

Answer: A

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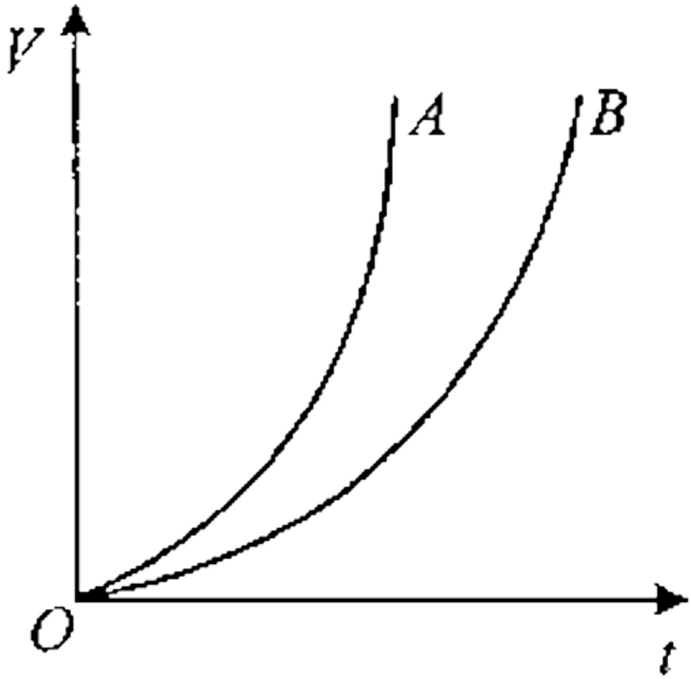
22. A time-velocity graph of two vehicles A and B starting from rest at the same time is given in the figure-1.107. The statement that can be deduced correctly from the graph is :



A. Acceleration of A is greater thanthat of B

B. Acceleration of B is greater than that of

A

C. Acceleration of A is increasing at a slower rate than that of B

D. Velocity of B is greaterthan that of A.

Answer: A

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23. Mark the correct statements :

A. The magnitude of the instantaneous velocity of a particle is equal to its instantaneous speed.

B. The magnitude of average velocity in an interval is equal to its average speed in that interval.

C. It is possible to have a situation in which the speed ofa particle is always zero but the average speed is not zero.

D. It is possible to have a situation in which the speed of a particle is never zero but the average speed in an interval is zero.

Answer: A

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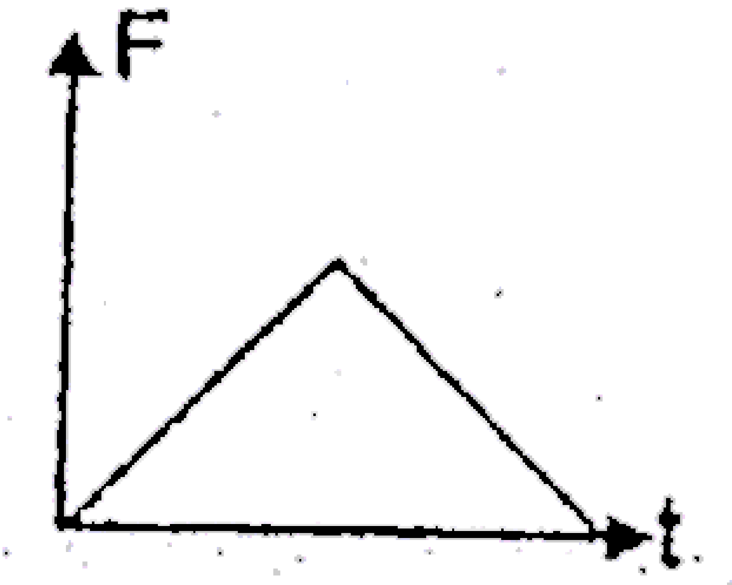
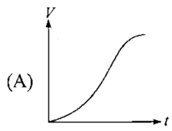
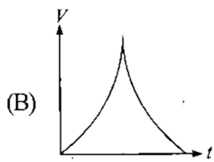
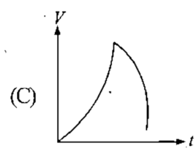
24. The force acting on a particle moving along a straight line varies with time as shown in diagram.

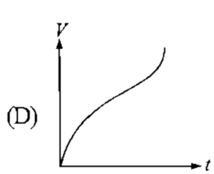


Which of the following graphs is best representative of its speed and time graphs. Initial velocity the particle is zero.

A. 

B. 

C. 

D. 

Answer: A

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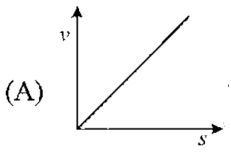
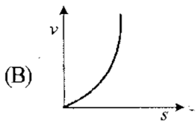
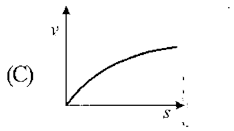
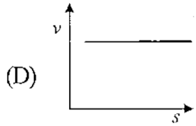
25. An object is dropped from rest. Its velocity versus displacement graph is:

A. 

B. 

C. 

D. 

Answer: C

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26. A stone is dropped from a balloon rising with acceleration a. The acceleration of the stone relative to the balloon is :

A. g downward

B. g +a downward

C. g-a upward

D. g + a upward

Answer: B

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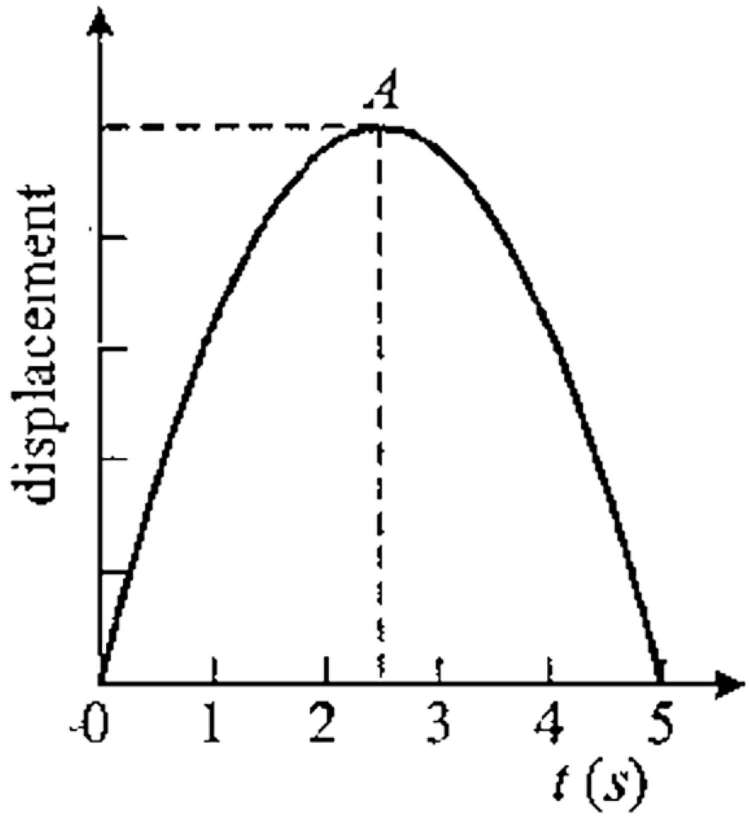
27. The Figure-1.109 shows the displacement-time graph ofa body subject only to the force of gravity. This graph indicates that:



A. At A, the acceleration is zero

B. At A, the velocity is maximum

C. At A, the displacement is zero

D. The acceleration is constant for all times shown

Answer: D

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28. Two particles are projected simultaneously in the same vertical plane from the same point, with different speeds u_1 and u_2, making angles θ_1 and θ_2 respectively with the horizontal, such that $u_1 \cos\theta_1 = u_2 \cos\theta_2$. The path followed by one, as seen by the other (as long as both are in flight), is

A. A horizontal straight line

B. A vertical straight line

C. A parabola

D. A straight line making an angle $|\theta_1 - \theta_2|$ with the horizontal.

Answer: B

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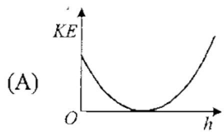
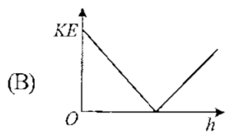
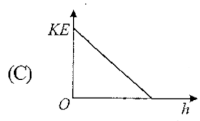
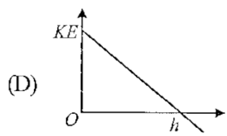
29. A ball is projected vertically up with an initial velocity. Which of the following graphs represents the KE of the ball?

A. 

B. 

C. 

D. 

Answer: C

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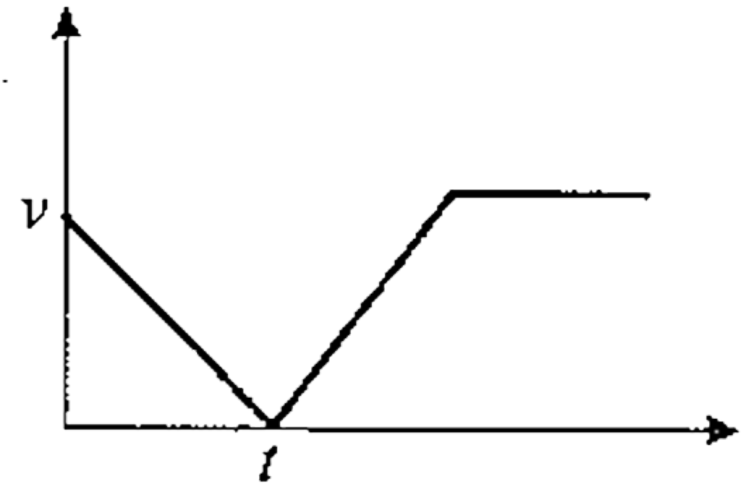
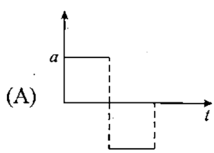
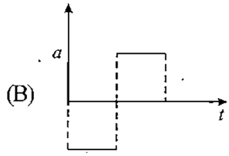
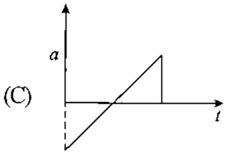
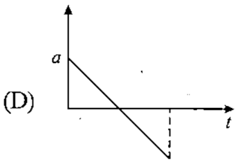
30. The velocity of a particle moving in straight line is given by the graph shown here. Then its acceleration is best represented by :



A. 

B. 

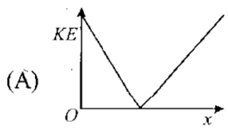
C. 

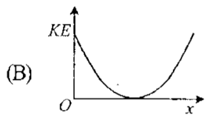
D. 

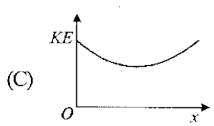
Answer: B

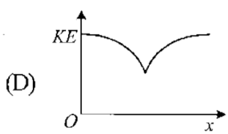
Watch Video Solution

31. A ball is thrown up with a certain velocity at angle θ to the horizontal. The kinetic energy varies with height h of the particle as:

A. 

B. 

C. 

D. 

Answer: C

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32. A small object is dropped from the top of a building and- falls to the ground. As it falls, accelerating due to gravity, it passes window. It has speed v_1 at the top of the window and speed v_2 at the bottom of the window, at what point does it have speed $\frac{v_1 + v_2}{2}$? Neglect the air resistance.

A. It depends on the height of the window or its distance from the top of the building.

B. Above the centre point of the window

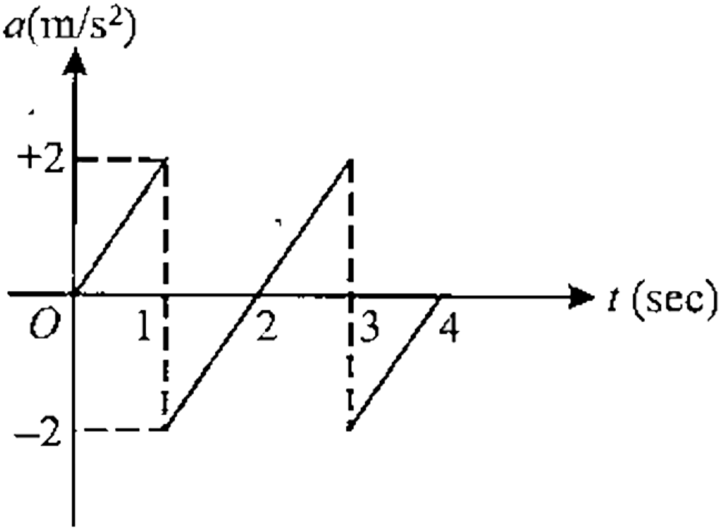
C. Below the centre point of the window

D. At the centre point of the window

Answer: B

Watch Video Solution

33. Acceleration vs time graph is shown in the figure for a particle moving along a straight line. The particle is initially at rest. Find the time instant(s) when the particle comes to rest?



A. $t=0, 1, 2, 3, 4$

B. $t=0, 2, 4$

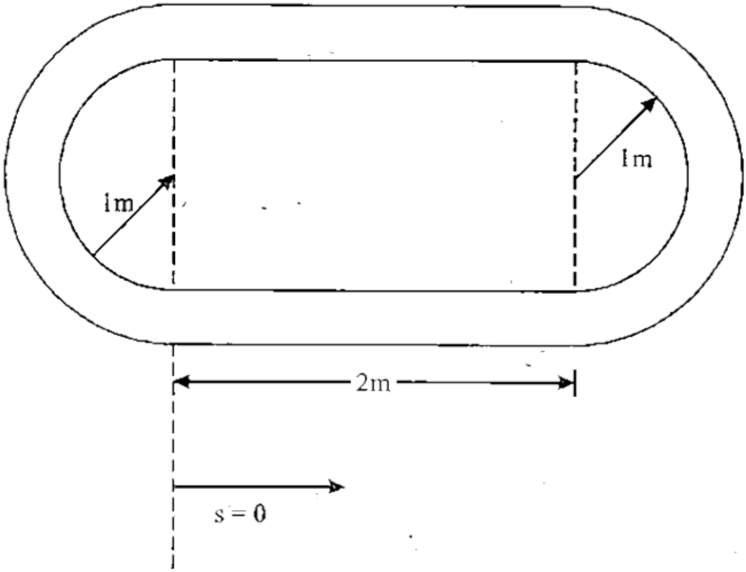
C. $t=1, 3$

D. None of these

Answer: B

Watch Video Solution

34. A toy car is moving on a closed track whose curved portions are semicircules of radius 1 m. The adjacent graph describes the variation of speed of the car with distance moved by it (starting from point P). The time t required for the car to complete one lap is equal to 6K second. Find K. (take $\pi \ln 2 \approx 2$)



A. 4

B. 8

C. 12

D. 16

Answer: B

Watch Video Solution

35. Which of the following sets of displacements might be capable of returning a car to its starting point?

A. 4, 6, 8 and 15 km

B. 10, 30, 50 and 120 km

C. 5, 10, 30 and 50 km

D. 40, 50, 75 and 200 km

Answer: A

Watch Video Solution

Numerical

1. A particle starts moving in +ve x direction with initial velocity of $10ms^{-1}$ with a uniform acceleration of magnitude $2ms^{-2}$ but directed in -ve x direction. What is the distance traversed by the particle in 12 seconds:

A. $-24m$

B. $24m$

C. $70m$

D. $74m$

Answer: D

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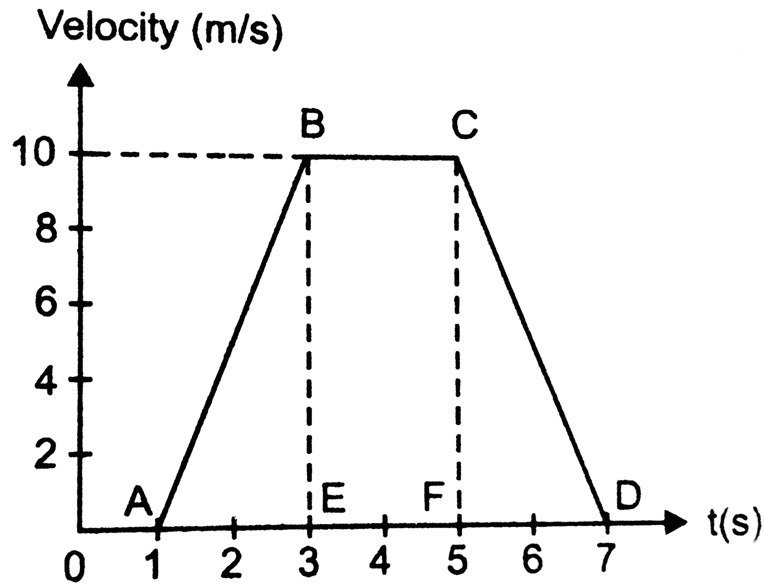
2. For the velocity time graph shown in Fig. 2 (CF).14, the distance covered by the body in last two seconds of its what fraction if the total distance covered by it in all the seven

seconds?



A. $1/2$

B. $2/3$

C. $1/4$

D. $1/3$

Answer: D

Watch Video Solution

3. A particle is moving in a straight line and passes through a point O with a velocity of $6ms^{-1}$ The particle moves with a constant retardation of $2ms^{-2}$ for 4 s and there after moves with constant velocity. How long after leaving O does the particle return to O

A. 8 s

B. Never

C. 4 s

D. 6 s

Answer: A

Watch Video Solution

4. The velocity ofacar travelling on a straight road is given by the equation $v = 6 + 8t - t^2$ where vis in meters per second and t in seconds. The instantaneous acceleration when $t = 4.5 s$ is :

A. $0.1 m/s^2$

B. $1 m/s^2$

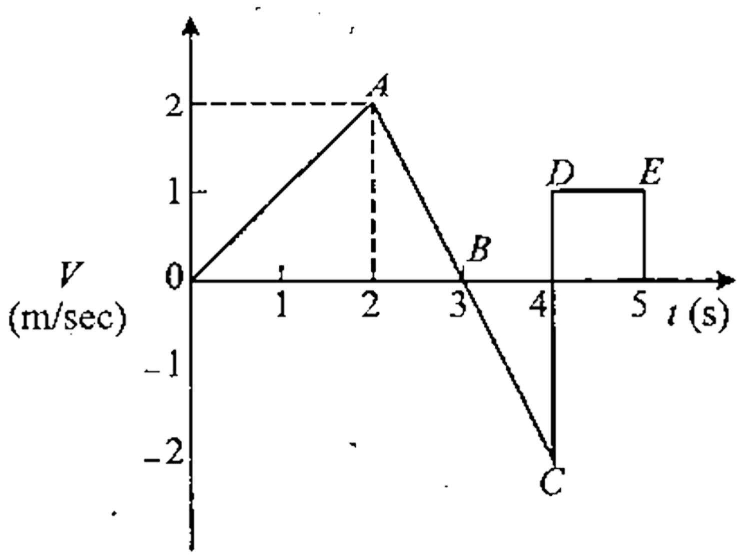
C. $-1 m/s^2$

D. $-0.1 m/s^2$

Answer: C

Watch Video Solution

5. The following figure-1.114 shows the linear motion velocity-time graph of a body.The body will be displaced in 5 seconds by:



A. 2 m

B. 3 m

C. 4 m

D. 5 m

Answer: B

Watch Video Solution

6. In the above question, the acceleration in the portion OA of the curve will be :

A. Zero

B. $2m/\sec^2$

C. $1m/\sec^2$

D. $0.5m / \sec^2$

Answer: C

Watch Video Solution

7. In the above question, which portion of the will have zero acceleration:

A. OA

B. AB

C. CD

D. DE

Answer: D

Watch Video Solution

8. A particle has initial velocity of $17ms^{-1}$ towards east and constant acceleration of $2ms^{-2}$ due west. The distance covered by it in 9th second of motion is :

A. 0 m

B. 0.5 m

C. 72 m

D. 2 m

Answer: B

Watch Video Solution

9. A ball is thrown vertically upwards from the ground. It crosses a point at the height of 25 m twice at an interval of 4 secs. The ball was thrown with the velocity of

A. 20 m/sec

B. 25 m/sec

C. 30 m/sec

D. 35 m/sec

Answer: C

Watch Video Solution

10. The velocity of a particle moving on the $x-$ axis is gienv by $v = x^2 + x($ for $x > 0)$ where v is in m/s and x is in m. Find its acceleration in m/s^2 when passing through the point $x = 2m$

A. 0

B. 5

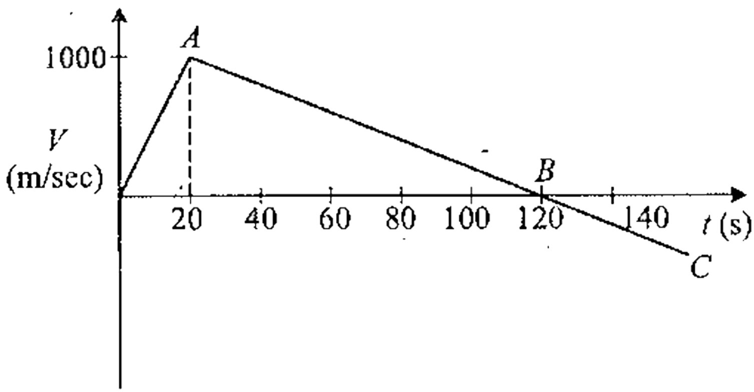
C. 11

D. 30

Answer: D

Watch Video Solution

11. A rocket is projected vertically upwards and its time velocity graph is shown in the figure-1.115. The maximum height attained by the rocket is :



A. 1 Km

B. 10 Km

C. 100 Km

D. 60 Km

Answer: D

Watch Video Solution

12. In the previous question, the height attained by the rocket before deceleration is :

A. 1 Km

B. 10 Km

C. 20 Km

D. 60 Km

Answer: B

Watch Video Solution

13. In the previous question, the mean velocity of the rocket reaching the maximum height is :

A. 100 m/sec

B. 50 m/sec

C. 500 m/sec

D. 25/3 m/sec

Answer: C

Watch Video Solution

14. In the above question, the acceleration of the rocket is :

A. $50m / \sec^2$

B. $100m / \sec^2$

C. $500m / \sec^2$

D. $10m/\sec^2$

Answer: A

Watch Video Solution

15. The engine of a motoecycle can produce a maximum acceleration of $5m/s^2$. Its brakes can produce a maximum retardation of $10m/s^2$. What is the minimum time in which the motorcycle can cover a distance of $1.5km$?

A. $5s$

B. $10s$

C. $15s$

D. $30s$

Answer: D

Watch Video Solution

16. Two balls are dropped from the same point after an interval of 1s. If acceleration due to gravity is $10m/s^2$, what will be their separation 3 seconds after the release of first ball?

A. 5 m

B. 10 m

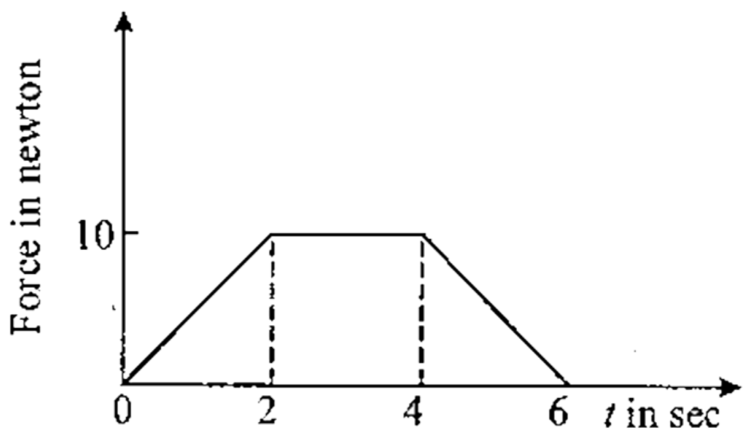
C. 25 m

D. 30 m

Answer: C

Watch Video Solution

17. The following figure-1.116 shows the time and applied force graph for a body. What will be the momentum gained by the body in 6 seconds :



A. Zero

B. 60 N-s

C. 30 N-s

D. 40 N-s

Answer: D

Watch Video Solution

18. A person throws balls into the air one after the other at an interval ofone second. The next ball is thrown when the velocityof the ball thrown earlier is zero. To what height the ball rise:

A. 5m

B. 10m

C. 20 m

D. 40m

Answer: A

Watch Video Solution

19. A body starts from rest and moves for n seconds with uniform acceleration a, its velocity after n seconds is v. The displacement of the body in last 3 seconds is :

A. $\dfrac{v(6n-9)}{2n}$

B. $\dfrac{2v(6n-9)}{n}$

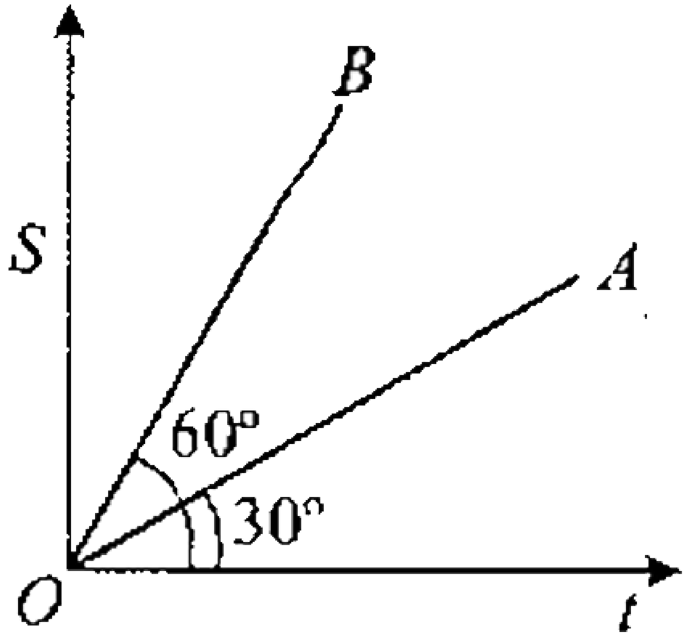
C. $\dfrac{2v(2n+1)}{n}$

D. $\dfrac{2v(n-1)}{n}$

Answer: A

Watch Video Solution

20. The displacement-time graph for two particle A and B straight lines inclined at angle of 30° and 90° with the time axis. The ratio of the velocities V_A and V_B is :



A. $1:2$

B. $1:\sqrt{3}$

C. $\sqrt{3}:1$

D. $1:3$

Answer: D

Watch Video Solution

21. A particle has an initial velocity of $9m/s$ due east and a constant acceleration of $2m/s^2$ due west. The distance coverd by the particle in the fifth second of its motion is :

A. 0

B. $0.5m$

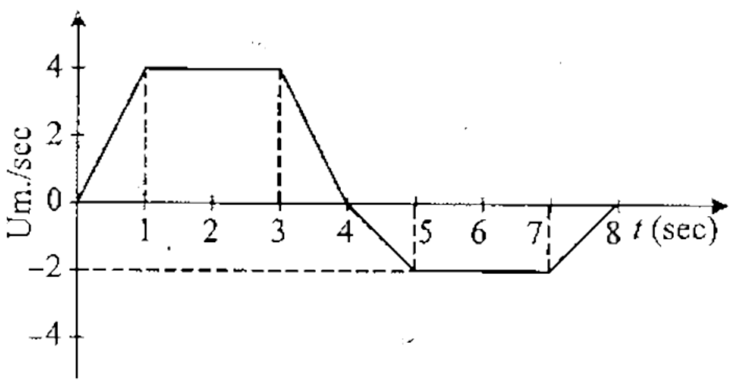
C. $2m$

D. None of these

Answer: B

Watch Video Solution

22. The velocity-time graph of a linear motion is shown below. The distance from the origin after 8 seconds is :



A. 18 m

B. 16 m

C. 8 m

D. 6 m

Answer: D

Watch Video Solution

23. Water drops fall at regular intervals from a roof. At an instant when a drop is about to leave the roof, the separations between 3 successive drops below the roof are in the ratio

A. $1:2:3$

B. $1:4:9$

C. $1:3:5$

D. $1:5:13$

Answer: C

Watch Video Solution

24. A body is in straight line motion with an acceleration given by $a = 32 - 4v$. The initial conditions are at $t = 0, v = 4$. Find the velocity when $t = \ln 2$:

A. $15/2$

B. $17/2$

C. $23/4$

D. $31/4$

Answer: D

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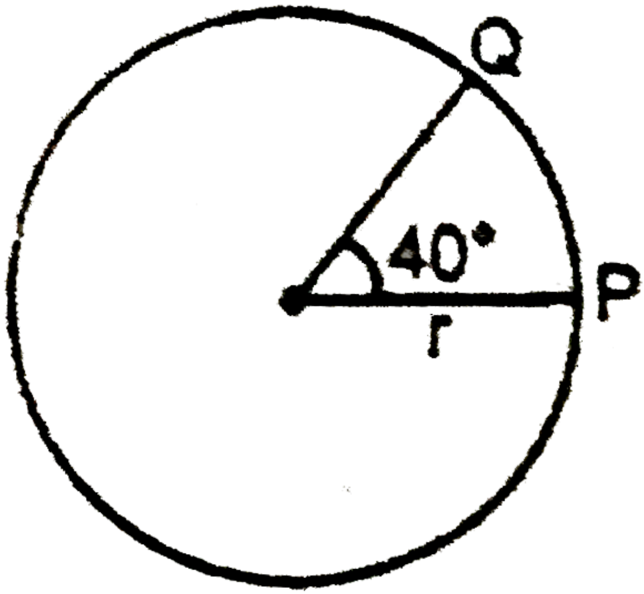
Watch Video Solution

25. A particle is moving in a circle of radius r with speed v as shown in the figure. The magnitude of change in velocity in moving from P to Q is



A. $2v\cos 40^\circ$

B. $2v\sin 40^\circ$

C. $2v\cos 20^\circ$

D. $2v\sin 20^\circ$

Answer: D

Watch Video Solution

26. A car accelerates from rest at constant rate for the first 10 s and covers a distance x. It covers a distance y in the next 10 s at the same acceleration. Which of the following is true?

A. $x = 3y$

B. $y = 3x$

C. $x = y$

D. $y = 2x$

Answer: B

Watch Video Solution

27. A particle starts from rest and moves with acceleration a which varies with time t as $a = kt$ where k is a costant. The displacement s of the particle at time t is

A. $\frac{1}{2}kt^2$

B. $\frac{1}{2}at^2$

C. $\frac{1}{6}at^2$

D. None

Answer: C

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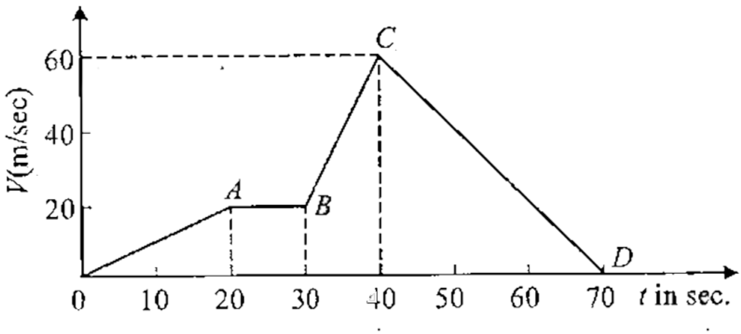
Watch Video Solution

28. The following shows the time-velocity graph for a moving object. The maximum acceleration will be:



A. $1m/\sec^2$

B. $2m/\sec^2$

C. $3m/\sec^2$

D. $4m/\sec^2$

Answer: D

Watch Video Solution

29. In the above question the magnitude of retardation will be:

A. $1m/\sec^2$

B. $2m/\sec^2$

C. $3m/\sec^2$

D. $4m/\sec^2$

Answer: B

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30. A rocket is fired vertically upwards and moves with net acceleration of $10m/s^2$. After 1 min the fuel is exhausted. The time taken by it to reach the highest point after the fuel is exhausted will be:

A. 10 sec

B. 20 sec

C. 30 sec

D. 60 sec

Answer: D

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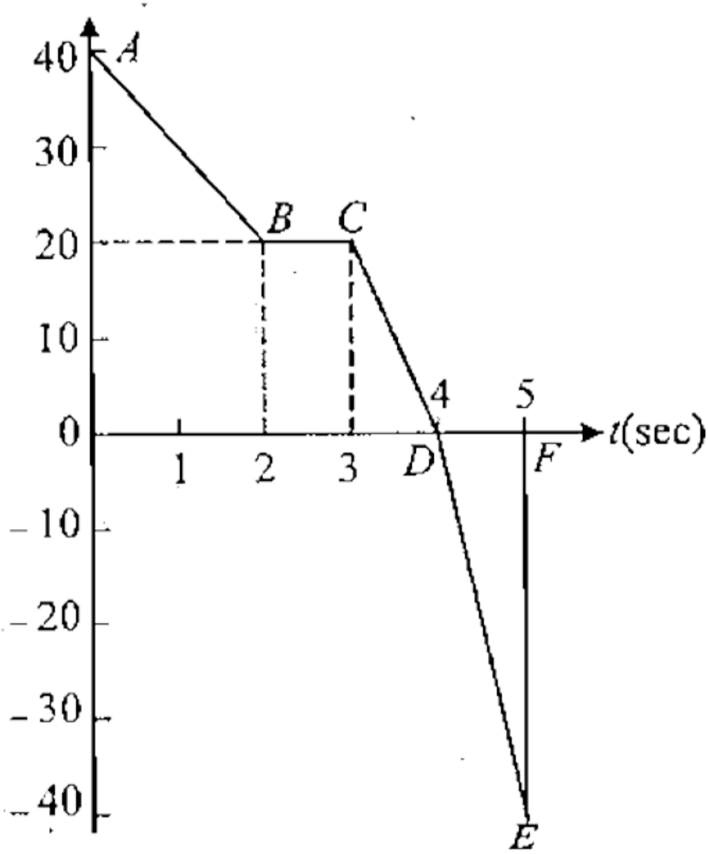
31. In the following velocity-time graph of a body, the distance and displacement travelled by the body in 5 seconds in meters will be:



A. 70, 110

B. 110, 70

C. 40, 70

D. 90, 50

Answer: B

Watch Video Solution

32. The displacement x of a body varies with time t as $x = -\frac{2}{3}t^2 + 16t + 2$. The body will come to rest after :

A. 6 s

B. 12 s

C. 18 s

D. 20 s

Answer: B

Watch Video Solution

33. A particle moves along X-axis in such a way that its coordinate X varies with time t according to the equation $x = (2 - 5t + 6t^2)m$. The initial velocity of the particle is

A. $2m / s$

B. $-5m / s$

C. $6m / s$

D. $-3m / s$

Answer: B

Watch Video Solution

34. A parachutist drops first freely from a plane for $10s$ and then his parachute opens out. Now he descends with a net retardation of $2.5ms^{-2}$ If he bail out of the plane at a height of $2495m$ and $g = 10ms^{-2}$, his velocity on reaching the ground will be`.

A. 2.5 m/s

B. 7.5 m/s

C. 5 m/s

D. 10 m/s

Answer: C

Watch Video Solution

35. The acceleration of a'particle starting from rest, varies with time according to the relation $a = kt + c$. The velocity of the particle after time t will be :

A. $kt^2 + ct$

B. $1.2kt^2 + ct$

C. $\frac{1}{2}(kt^2 + ct)$

D. $kt^2 + \frac{1}{2}ct$

Answer: B

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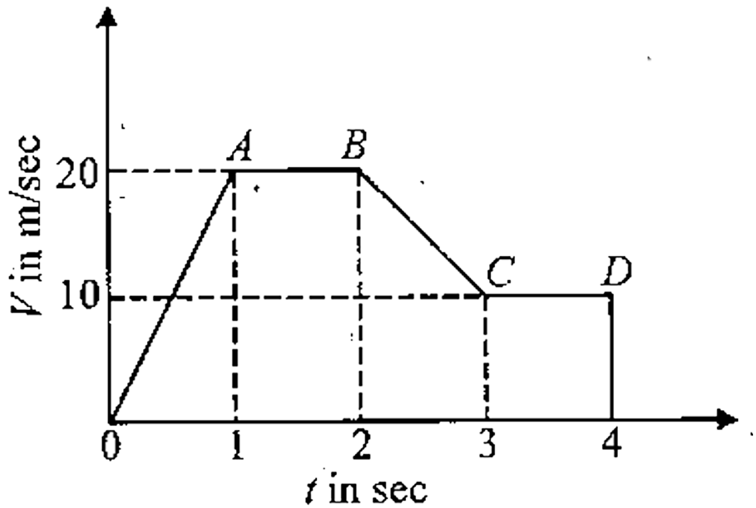
36. The variation ofvelocity ofa particle moving along a straight line is illustrated in the following figure-1.122. The distance covered by the particle in 4 seconds is :



A. 60 m

B. 25 m

C. 55 m

D. 30 m

Answer: C

Watch Video Solution

37. A street car moves rectilinearly from station A to the next station B with an acceleration varying according to the law $f = a - bx$, where a and b are constants and x is the distance from station A. The distance between the two stations & the maximum velocity are :

A. $x = \frac{2a}{b}, v_{\max} = \frac{a}{\sqrt{b}}$

B. $x = \frac{b}{2a}, v_{\max} = \frac{a}{b}$

C. $x = \frac{a}{2b}, v_{\max} = \frac{b}{\sqrt{a}}$

D. $x = \frac{a}{b}, v_{\max} = \frac{\sqrt{a}}{b}$

Answer: A

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38. When the speed of the car is v, the minimum distance over which it can be stopped is x. If the speed becomes nv, what will be the minimum distance over which it can be stopped during same time:

A. x / n

B. nx

C. x / n^2

D. $n^2 x$

Answer: B

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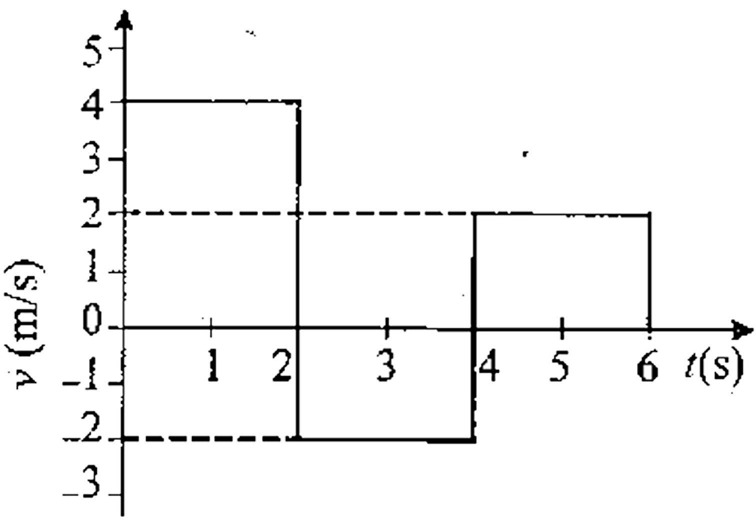
39. The following figure-l .123 shows the velocity-time graph of a moving body along a straight line. The displacement and distance travelled in six seconds be respectively given as :



A. 8m, 16 m

B. 16 m, 8 m

C. 16 m, 16 m

D. 8 m, 8 m

Answer: A

Watch Video Solution

40. A particle is moving in a straight line with initial velocity u and uniform acceleration f. If the sum of the distances travelled in

t^{th} and $(t+1)^{th}$ seconds is $100cm$, then its velocity after t seconds, in cm/s, is.

A. 20

B. 30

C. 50

D. 80

Answer: C

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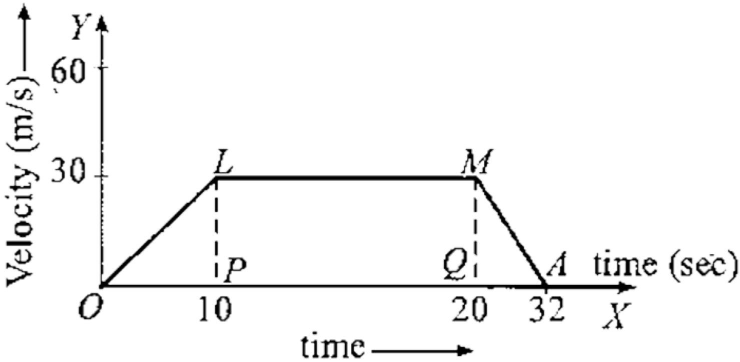
41. The following figure-1.124 shows the velocity-time graph of a train. The total distance travelled by the train is :



A. 780 m

B. 1200 m

C. 660 m

D. 1500 m

Answer: A

Watch Video Solution

42. A stone falls freely rest. The distance covered by it in the last second is equal to the distance covered by it in the first 2 s. The time taken by the stone to reach the ground is

A. 4 s

B. 5 s

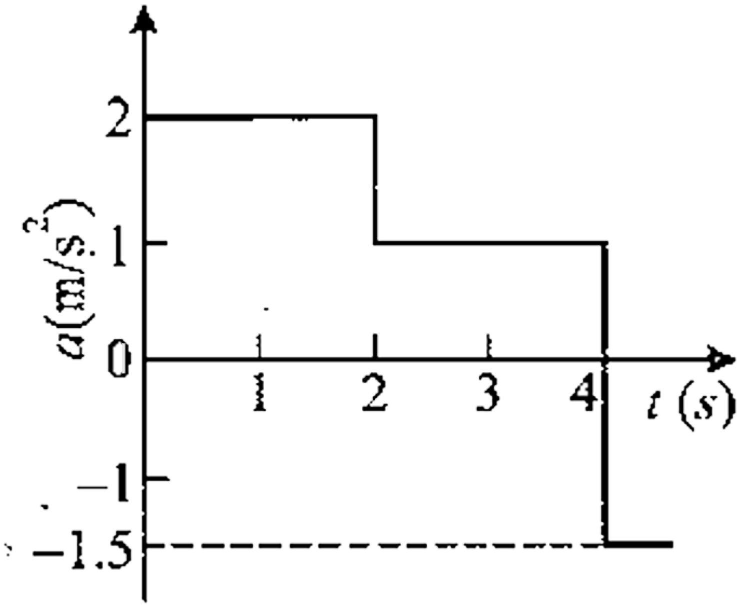
C. 6 s

D. 7 s

Answer: B

Watch Video Solution

43. The figure-1.125 shows the acceleration versus time graph of a train. If it starts from rest, the distance it travels before it comes to rest is :



A. 30 m

B. 26 m

C. 13 m

D. 40 m

Answer: B

Watch Video Solution

44. A particle moving on a straight line ultimately comes to rest ? What is the angle between its initial velocity and acceleration ?

A. Zero

B. $\pi / 4$

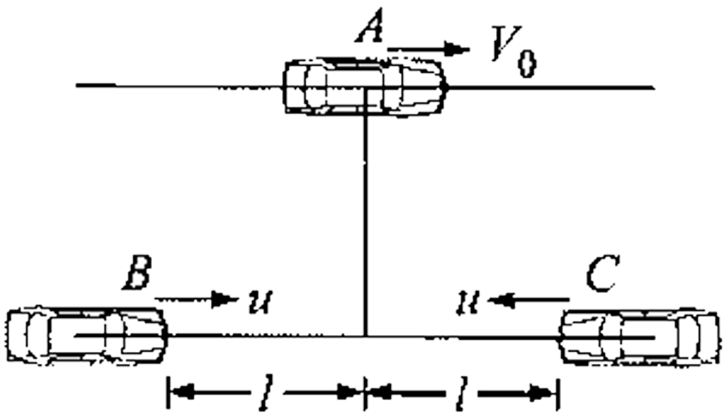
C. $\pi / 2$

D. π

Answer: D

Watch Video Solution

45. Ona twolaneroada carAistravelling witha speedof $v = 5ms^{-1}$. Two car B and C approach car A in opposite direction with a speed $u = 10ms^{-1}$ each. At a certain instant when the B and C are equidistant from A each being $l = 1500m$, B decides to overtake A before C does. What minimum acceleration of car B is required to avoid an accident with C:



A. $-0.2ms^{-2}$

B. $-1/15ms^{-2}$

C. $0.2ms^{-2}$

D. $1/15ms^{-2}$

Answer: C

Watch Video Solution

46. Two cars get closer by 8 m every second while traveling in the opposite directions. They get closer by 0.8 m while traveling in the same directions. What are the speeds of the two cars ?

A. 4 m/s and 4.4 m/s

B. 4.4 m/s and 3.6 m/s

C. 4 m/s and 3.6 m/s

D. 4 m/s and 3 m/s

Answer: B

Watch Video Solution

47. At rain 200m long moving at constant acceleration crosses a bridge 300 m long. It enters the bridge with a speed of 3m/s and leaves it with a speed of 5m/s. What is the time taken to cross the bridge ?

A. 25 s

B. 75 s

C. 125 s

D. 150 s

Answer: C

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48. A ball is dropped from top of a tower of 100 m height. Simultaneously another ball was thrown upward from bottom of the tower with a speed of $50m/s(g=10m/s^2)$. They will cross each other after

A. 1 s

B. 2 s

C. 3 s

D. 4 s

Answer: B

Watch Video Solution

49. A truck travelling due north at 20 m/s turns east and travels at the same speed. What is the change in velocity :

A. 40 m/s north east

B. $20\sqrt{2}$ m/s south east

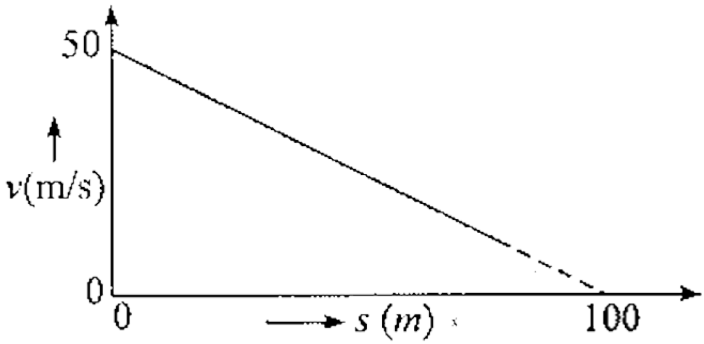
C. $20\sqrt{2}$ m/s south west

D. $20\sqrt{2}$ m/s north west

Answer: B

Watch Video Solution

50. If the velocity v of a particle moving along a straight line decreases linearly with its position coordinates s from 50m/s to a value approaching zero at = 100 m, the time it takes to reach the 100 m position will be:



A. 10 s

B. 5 s

C. Infinity

D. 0.5 s

Answer: C

Watch Video Solution

51. A particle moves towards east with velocity $5m/s$. After $10 \sec onds$ its direction changes towards north with same Velocity. The average acceleration of the particle is

A. 0

B. $1/\sqrt{2}m/s^2$ north west

C. $1/\sqrt{2}ms^2$ north east

D. $\sqrt{2}m/s^2$ north east

Answer: B

Watch Video Solution

52. A body of mass 2kg is moving along north-east direction with a speed $\sqrt{2}$ m/s. A force of $0.2N$ is applied on the body due west for 10 sec. The final velocity ofthe body is :

A. 1 m/s due north

B. 1 m/s due east

C. 2 m/s due north

D. 2 m/s due east

Answer: A

Watch Video Solution

53. A person moves 30m north and then 20 m towards east and finally $30\sqrt{2}$m in south-west direction. The displacement of the person from the origin will be

A. 14 m south west

B. 20 m south

C. 10 m west

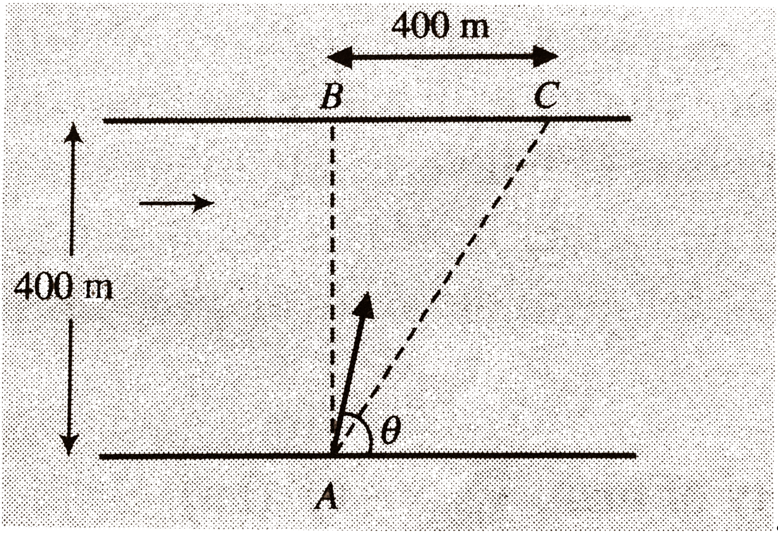
D. 15 m east

Answer: C

Watch Video Solution

54. A river is flowing with a speed of $1 kmh^{-1}$ A swimmer wants to go point C starting from A. He swims with a speed of $5 kmh^{-1}$ at an angle θ w.r.t. the river flow. If

$AB = BC = 400m$, at what angle with the river bank should the swimmer swim ?



.

A. 37°

B. 30°

C. 53°

D. 45°

Answer: C

Watch Video Solution

55. A blind person after walking each 10 steps in one direction, each of length 80 cm, turns randomly the left or to right by 90°. After walking a total of 40 steps the maximum possible displacement the person from his starting position could be (A) 320 m (B) 32 m (C) $\frac{16}{\sqrt{2}}$ m (D) $16\sqrt{2}$ m

A. 30 m

B. $16\sqrt{2}m$

C. $8\sqrt{2}m$

D. 0 m

Answer: B

Watch Video Solution

56. A person standing on the roof of a house of height h throws a particle vertically downwards and otherparticle in a horizontal direction with the same speed u. The ratio ofspeeds of the particles on reaching the earth is :

A. $\sqrt{2gh} : u$

B. $1 : 2$

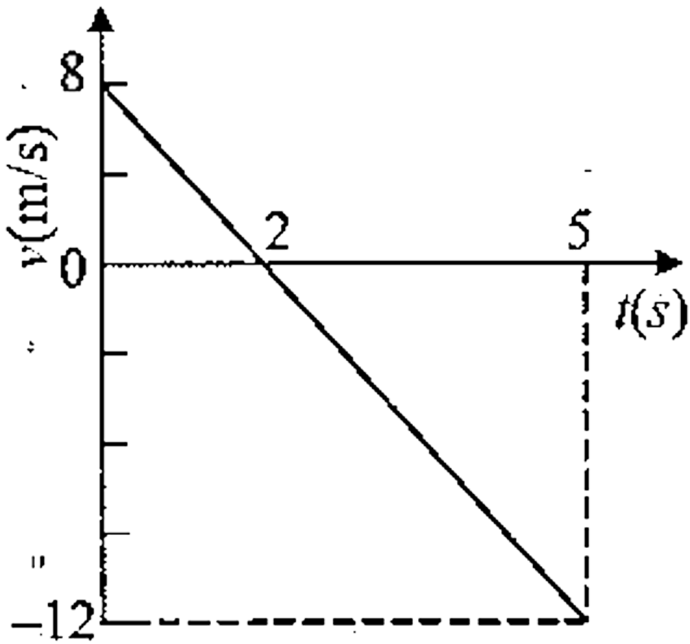
C. $\sqrt{2} : 1$

D. $1 : 1$

Answer: D

Watch Video Solution

57. A particle moves along a horizontal straight line with a velocity-time relationship as shown in the figure-1.129. The total distance moved by the particle is :



A. 39 m

B. 13 m

C. 26 m

D. 2.6 m

Answer: C

Watch Video Solution

58. A car is going east wards with a velocity of 8m/s. To the passengers in the car, a train appears to be moving north wards with a velocity of 15 m/s. What is the actual velocity of the train:

A. 7 m/s

B. 17 m/s

C. 23 m/s

D. None of these

Answer: B

Watch Video Solution

59. Rain is falling vertically with a velocity of 3 kmh^{-1}. A man walks in the rain with a velocity of $4kmh^{-1}$. The rain drops will fall on the man with a velocity of

A. 1 kph

B. 3 kph

C. 2 kph

D. 5 kph

Answer: D

Watch Video Solution

Watch Video Solution

60. A man walks in rain with a velocity of 5 kmph. The rain drops strike at him at an angle of 45° with the horizontal. The downward velocity of the rain drops will be :

A. 5 kph

B. 4 kph

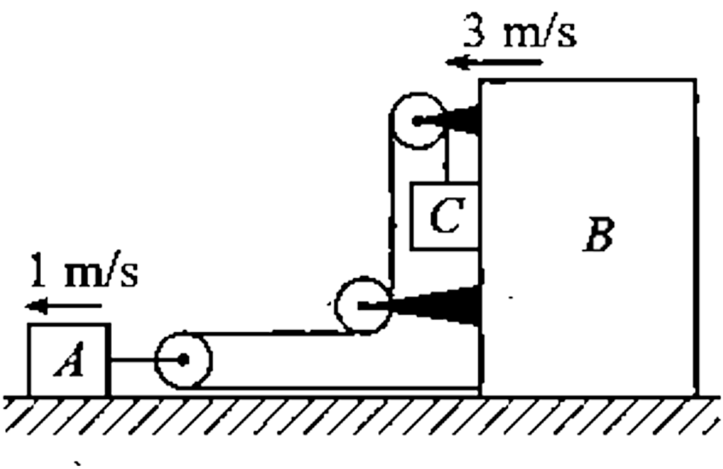
C. 3 kph

D. 1 kph

Answer: A

Watch Video Solution

61. The velocities of A and B are marked in the figure-1.130. The velocity of block C is (assume that the pulleys are ideal and string inextensible) :



A. 5 m/s

B. 2 m/s

C. 3 m/s

D. 4 m/s

Answer: A

Watch Video Solution

62. If θ is the angle between the velocity and acceleration of a projectile at a point of its path, its value when the projectile is at the highest point is :

A. 0°

B. 180°

C. 90°

D. 45°

Answer: C

Watch Video Solution

63. If the angle of projection θ corresponds to horizontal range being equal to the maximum height then $\tan \theta$ equals :

A. 1

B. $1/\sqrt{3}$

C. $\sqrt{3}$

D. 4

Answer: D

Watch Video Solution

64. A thief is running away on a straight road in a jeep moving with a speed of 9m/s. A police man chases him on a motor cycle moving at a speed of 10 m/s. If the instantaneous separation of the jeep from the motorcycle is 100m, how long will it take for the police man to catch the thief?

A. 1 s

B. 19 s

C. 90 s

D. 100 s

Answer: D

Watch Video Solution

65. Two cars are moving in the same direction with the same speed $30 km / hr$. They are separated by a distance of $5 km$, the speed of a car moving in the opposite direction of it meets these two cars at an interval of 4 minutes, will be.

A. 30 kph

B. 35 kph

C. 40 kph

D. 45 kph

Answer: D

Watch Video Solution

66. A particle is projected upwards with a velocity of 110m/sec at an angle of 60° with the vertical. Find the time when the particle will move perpendicular to its initial direction, taking g $= 10m/\sec^2$

A. 10 seconds

B. 22 seconds

C. 5 secomds

D. $10\sqrt{3}$ seconds

Answer: B

Watch Video Solution

67. The horizontal range of a projectile is R and the maximum height at tained by it is H. A strong windnow begins to blow in the direction of the motion of the projectile, giving it a constant horizontal acceleration = g/2. Under the same conditions of projection, the horizontal range of the projectile will now be:

A. $R + \frac{H}{2}$

B. $R + H$

C. $R + \frac{3H}{2}$

D. $R + 2H$

Answer: D

Watch Video Solution

68. Two particles, one with constant velocity 50 m/s and the other with uniform acceleration $10m/s^2$ start moving simultaneously from the same place in the same direction. They will be at a distance of 125m from each other after:

A. 5 sec.

B. $5(1+\sqrt{2})\text{sec}$

C. 10 sec

D. $10(\sqrt{2}+1)$ sec

Answer: A

Watch Video Solution

69. A stone is dropped from an aeroplane which is rising with acceleration $5ms^{-2}$. If the acceleration of the stone relative to the aeroplane be f, then the following is (are) true

:

A. $f = 5ms^{-2}$ downward

B. $f = 5ms^{-2}$ upwards

C. $f = 15ms^{-2}$ upward

D. $f = 15ms^{-2}$ downward

Answer: D

Watch Video Solution

70. A ball is thrown vertically upwards in air. If the air resistance can not be neglected (Assume it be directly proportionalto velocity) thenthe acceleration of the ball at the highest point will be :

A. 0

B. g

C. $>g$

D. $<g$

Answer: B

Watch Video Solution

71. If $y = x - x^2$ is the of the path of a projectile, then which of the following is incorrect:

A. Range =1 m

B. Maximum height =0.25 m

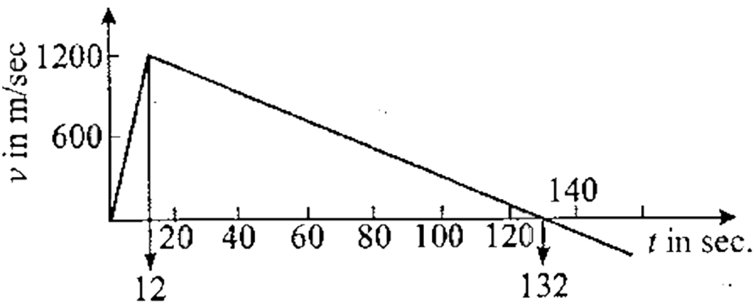
C. Time of flight =0.5 sec.

D. Angle of projection $= 45^\circ$

Answer: C

Watch Video Solution

72. A rocket is fired upwards. Its velocity versus time graph is shown in the figure-1.131. The maximum height reached by the rocket is:



A. 7.1 km

B. 79.2 km

C. 72 km

D. Infinite

Answer: B

Watch Video Solution

73. A person walks up a stalled escalator in 90 s. When standingon the same escalator, now moving, he is carried in 60 s.The time it would take him to walk up the moving escalator will be:

A. 27 s

B. 72 s

C. 18 s

D. 36 s

Answer: D

Watch Video Solution

74. An object is thrown horizontally from a tower H meter high with a velocity of $\sqrt{2gH}$ m/s. Its velocity on striking the ground will be :

A. $\sqrt{2gH}$

B. $\sqrt{6gH}$

C. $2\sqrt{gH}$

D. $2\sqrt{2gH}$

Answer: C

Watch Video Solution

75. For a train that travels from one station to another at a uniform speed of $40kmh^{-1}$ and returns to initial station at speed of $60 km h^{-1}$

then its average speed is

A. 48 km/hr, zero

B. 36 km/hr, zero

C. 24 km/hr, 24 km/hr

D. None of these

Answer: A

Watch Video Solution

76. A motor car is going due north at a speed of 50 km/h.It makes a 90° left turn without changing the speed. The change in the velocity of the car is about :

A. 50 km/h towards west

B. $50\sqrt{2}$ km/h towards south-west

C. 70 km/h towards north-west

D. Zero

Answer: B

Watch Video Solution

Watch Video Solution

77. A bird flies for 4 sec with a velocity of $|t-2|$ m/s in a straight line, where $t=$ time in seconds. It covers a distance of :

A. 2m

B. 4m

C. 6m

D. 8m

Answer: B

Watch Video Solution

78. Three particles A, B and C are thrown from the top of a tower with the same speed. A is thrown up, B is thrown down and C is thrown horizontally. They hit the ground with speeds v_A, v_B and v_C respectively then,

A. $v_A = v_B = v_C$

B. $v_A > v_B > v_C$

C. $v_A = v_B > v_C$

D. $v_A > v_B = v_C$

Answer: A

Watch Video Solution

79. A particle is thrown with a speed u at an angle θ with the horizontal. When the particle makes an angle ϕ with the horizontal. Its speed changes to v :

A. $v = u\cos\theta$

B. $v = u\cos\theta.\cos\phi$

C. $v = u\cos\theta.\sec\phi$

D. $v = u \sec\theta . \cos\phi$

Answer: C

Watch Video Solution

80. Two projectiles A and B are projected with angle of projecton 15° for the projectile A and 45° for the projectile B. If R_A and R_B be the horizontal range for the two projectiles then :

A. $R_A < R_B$

B. $R_A = R_B$

C. $R_A > R_B$

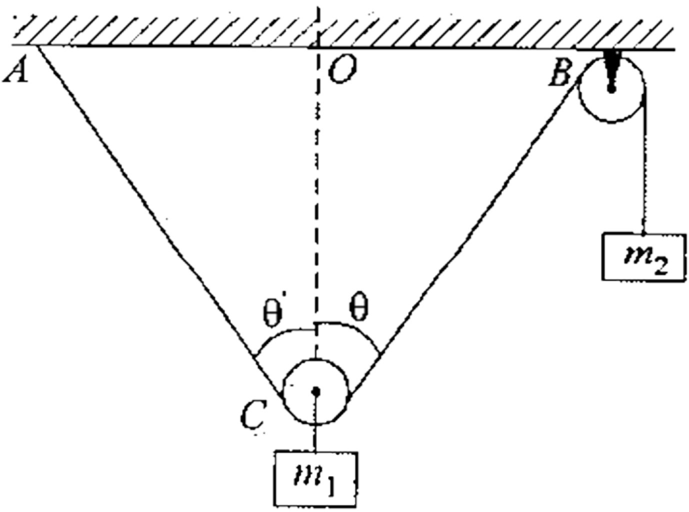
D. The information is insufficient to decide the relation of R_A with R_B.

Answer: D

Watch Video Solution

81. In the arrangement shown in the figure -1.132 if v_1 and v_2 are instaneous velocities of masses m_1 and m_2 respectively, and angle

$ACB = 2\theta$ at the instant then :



A. $\theta = \dfrac{\cos^{-1} v_2}{2v_1}$

B. $\theta = \dfrac{\cos^{-1} v_1}{2v_2}$

C. $\theta = \dfrac{\tan^{-1} v_1}{2v_2}$

D. $\theta = \dfrac{\sin^{-1} v_1}{v_2}$

Answer: A

Watch Video Solution

82. A man rows a boat with a speed of 18 km/hr in northwest direction. The shoeline makes an angle of 15° south of west. Obtain the component of the velocity of the boat along the shoreline:

A. 9 km/hr

B. $18\frac{\sqrt{3}}{2}$ km/hr

C. $18\cos 15^{\circ}$ km/hr

D. $18\cos 75^{\circ}$ km/hr

Answer: A

Watch Video Solution

83. A bullet is fired from a gun falls at a distance half of its maximum range. The angle of projection of the bullet can be :

A. 15°

B. 30°

C. 60°

D. 75°

Answer: A

Watch Video Solution

84. A bus begins to move with an accelaration of $1ms^{-1}$. A man who is $48m$ behind the bus starts running at $10ms^{-1}$ to catch the bus, the man will be able to catch the bus after .

A. 8 s

B. 10 s

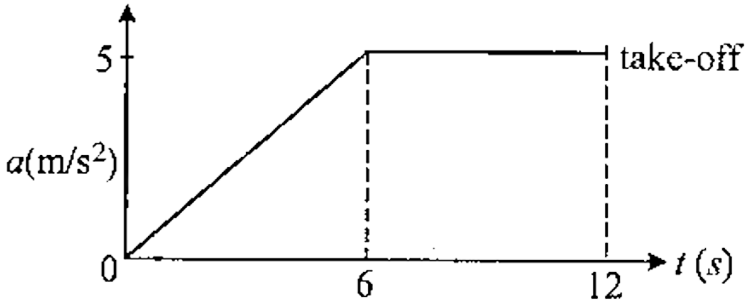
C. 12 s

D. 14 s

Answer: A

Watch Video Solution

85. An experiment on the take-off performance of an aeroplane shows that the acceleration varies as shown in the figure-I. 133, and that it takes 12s to take off from a rest position. The distance along the run way covered by the aeroplane is :



A. 210 m

B. 2100 m

C. 21000 m

D. 1200 m

Answer: A

Watch Video Solution

86. Wind is blowing in the north direction at speed of 2 m/s which causes the rain to fall at some angle with the vertical. With what velocity should acyclist drive so that the rain appears vertical to him:

A. 2 m/s south

B. 2 m/s north

C. 4 m/s west

D. 4 m/s south

Answer: B

Watch Video Solution

87. A particle has a velocity u towards east at $t = 0$. Its acceleration is towards west and is constant. Let x_A and x_B be the magnitude of displacements in the first 10 seconds and the next 10 seconds

A. $x_A < x_B$

B. $x_A = x_B$

C. $x_A > x_B$

D. The information is insufficient to decide the relation of x_A with x_B

Answer: D

Watch Video Solution

88. A particle thrown up vertically reaches its highest point in time t_1 and returns to the ground in a further time t_2. The air resistance exerts a constant force on the particle opposite to its direction of motion.

A. $t_1 > t_2$

B. $t_1 = t_2$

C. $t_1 < t_2$

D. may be (A) or (C) depending on the ratio of the force of air resistance to the wight of the particle.

Answer: C

Watch Video Solution

89. Three particles starts from origin at the same time with a velocity $2ms^{-1}$ along positive x-axis, the second with a velocity $6ms^{-1}$ along negative y-axis, Find the velocity of the third particle along $x = y$ line so that the three particles may always lie in a straight line.

A. $-3\sqrt{3}$ m/s

B. $3\sqrt{2}$ m/s

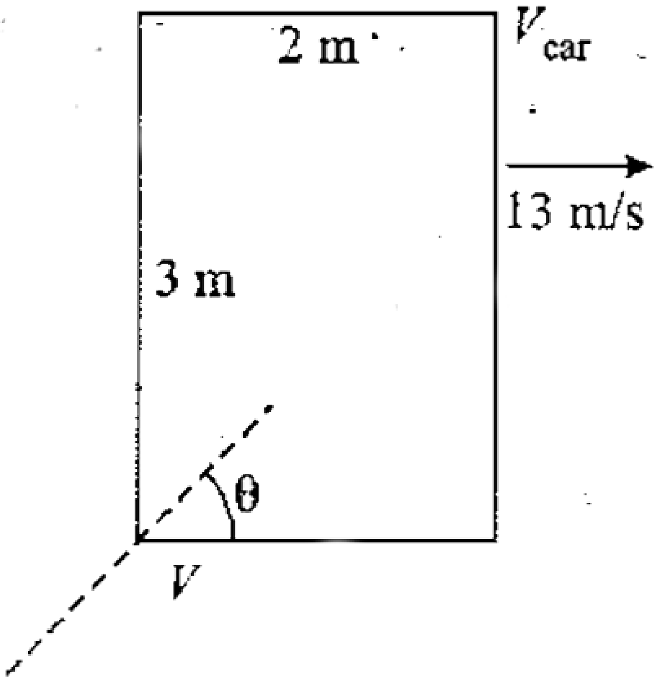
C. $-3\sqrt{2}$ m/s

D. $2\sqrt{2}$ m/s

Answer: B

Watch Video Solution

90. A car 2 m long and 3 m wide is moving at 13m/sec when a bullet hits it in a direction making an angle $\theta = \tan^{-1} 3/4$ with the car as seen from the street. The bullet enters one edge of the comer and passes out at the diagonally opposite comer. Neglectingany interaction between bullet and car find the time for the bullet to cross the car :



A. 0.25 sec

B. 1.3 sec

C. 0.15 sec

D. 0.6 sec

Answer: C

Watch Video Solution

91. Rain is falling with a speed of 4nVs inadirection making an angle of 30° with vertical towards south. What should be the magnitude & direction of velocity of cyclist to hold his umbrella exactly vertical, so that rain does not wet him:

A. 2 m/s towards north

B. 4 m/s towards south

C. 2 m/s towards south

D. 4 m/s towards north

Answer: C

Watch Video Solution

92. The greatest acceleration or deceleration that a train may have is a. The minimum time in which the train may reach form one station to the other seprated by a distance is-

A. $\sqrt{\frac{s}{a}}$

B. $\sqrt{\frac{2s}{a}}$

C. $\frac{1}{2}\sqrt{\frac{s}{a}}$

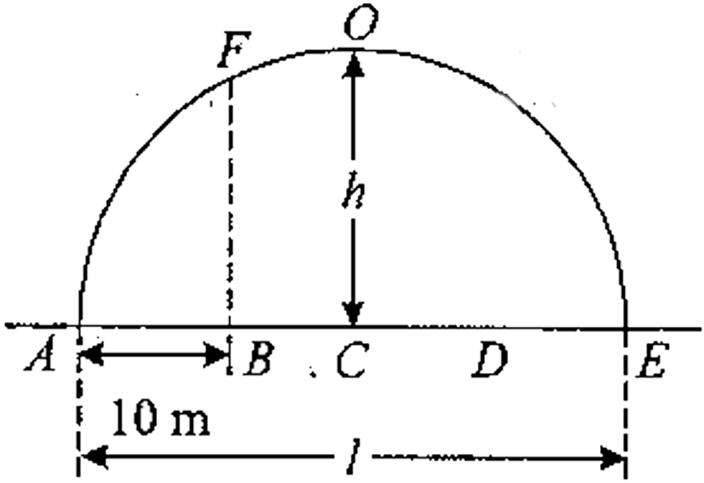
D. $2\sqrt{\frac{s}{a}}$

Answer: D

Watch Video Solution

93. A car of mass $= m = 1000kg$ is moving with constant speed $v = 100m/s$ on a parabolic shaped bridge AFOE of span force applied by the bridge on the car when he car

is at point E, is:



A. $5000\sqrt{\frac{5}{2}}N$

B. $\frac{5000}{\sqrt{2}}N$

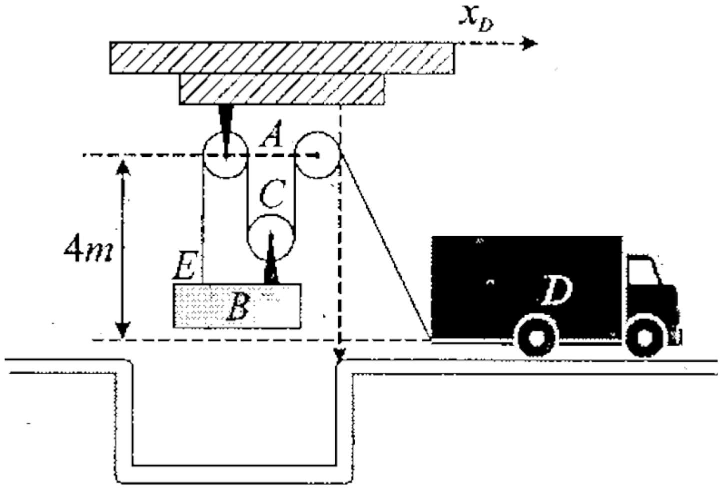
C. $\frac{10000}{\sqrt{2}}N$

D. $5000\sqrt{\frac{2}{5}}N$

Answer: A

Watch Video Solution

94. A block B is suspended from a cable that is attached to the block at E, wraps around three pulleys and is tied to the back of a truck D. Ifthe tmck starts from rest when x_D is zero and moves forward with a constant acceleration of $a_P = 3/2m/s^2$, if the speed of the block at the instant $x_D = 3m$ is :



A. $\frac{1}{5}m/s$

B. $\frac{2}{5}m/s$

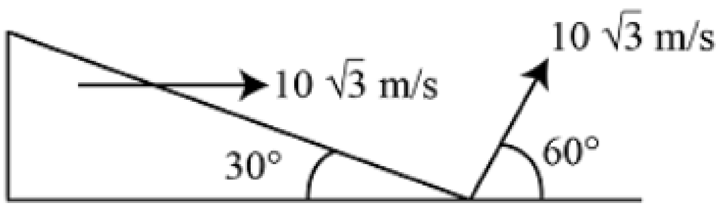
C. $\frac{3}{5}m/s$

D. $1m/s$

Answer: C

View Text Solution

95. A particle is projected at an angle 60° with speed $10(\sqrt{3})m/s$, from the point A, as shown in the figure. At the same time the wedge is made to move with speed $10(\sqrt{3})m/s$ towards right as shown in the figure. Then the time after which particle will strike with wedge is



A. 1 sec

B. 2 sec

C. 3 sec

D. it will never collide on the wedge

Answer: B

Watch Video Solution

96. An aeroplane flies along a straight line from A to B with a speed v_0 and back again. A steady wind v is blowing if $AB = l$ then a)total time for the trip is $\frac{2v_0 l}{v_0^2 - v^2}$ if wind blows along the line AB

b)total time for the trip is $2\frac{l}{\sqrt{v_0^2 - v^2}}$,if wind blows perpendicular to the line AB

c)total time for the trip decrease because of the presence of wind

d)total time for the trip increase because of the presence of wind

A. $T_w = T_0$

B. $T_w > T_0$

C. $T_w < T_0$

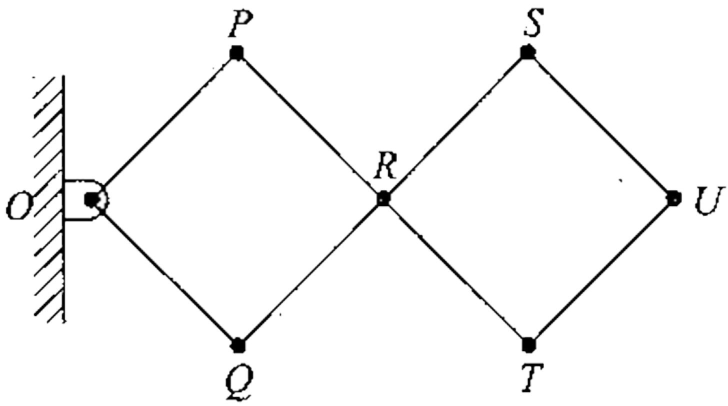
D. $T_w = 2T_0$

Answer: B

Watch Video Solution

97. In the arrangement of rigid links of equal length l, they can freely rotate about the joined ends as shown in the figure- 1.138. If the end U is pulled horizontally with constant speed 20 m/s, find the approx. speed of end P

when the angle SUT is 90°.



A. 5 m/s

B. 10 m/s

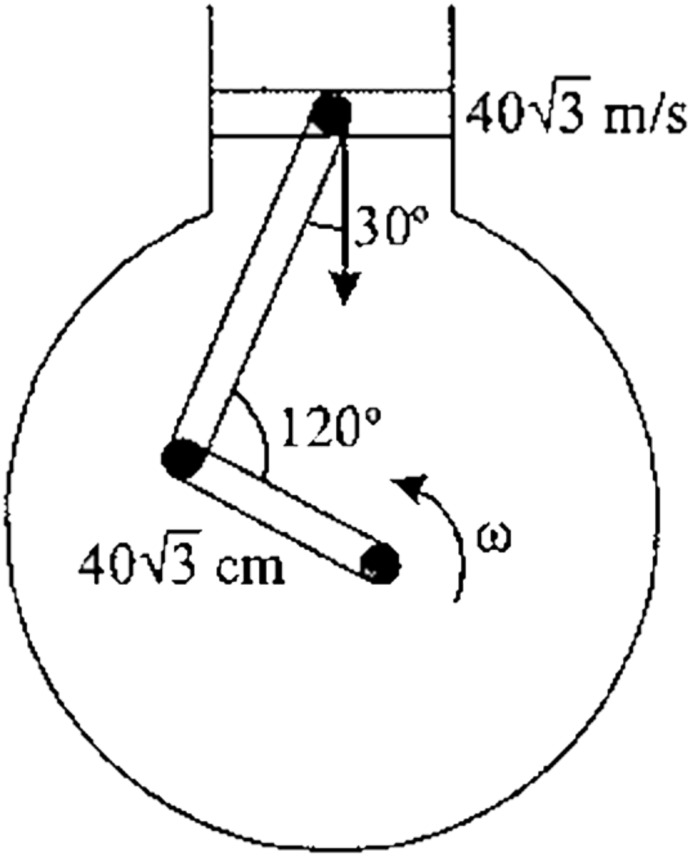
C. 7.1 m/s

D. 14.12 m/s

Answer: C

Watch Video Solution

98. A snapshot of apetrol engine is given in which piston is moving downwards with velocity $40\sqrt{3}$ m/s. Find the angular velocity of the shaft:



A. 100 rad/s

B. 300 rad/s

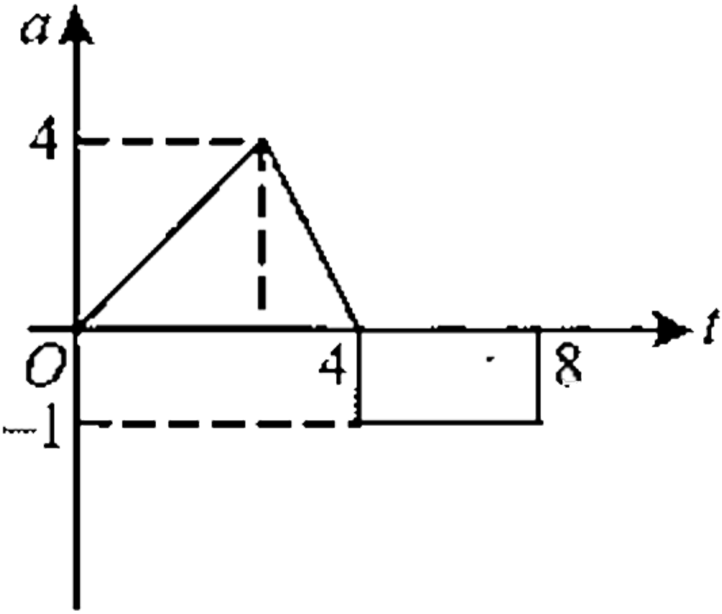
C. 200 rad/s

D. 500 rad/s

Answer: A

Watch Video Solution

99. The acceleration time graph of a particle is shown in the figure-1.140. What is the velocity of particle at t=8s, if initial velocity of particle is 3 m/s? (Assume motion is 1 dimension) :



A. 4 m/s

B. 5 m/s

C. 6 m/s

D. 7 m/s

Answer: D

Watch Video Solution

100. A particle is moving on a circular path of radius R with uniform angular speed ω. The magnitude of average velocityof particle during time $t=0$ to $t=\frac{2\pi}{3\omega}$:

A. $\frac{\sqrt{3}}{2}\frac{\omega R}{\pi}$

B. $\frac{3}{2}\frac{\omega R}{\pi}$

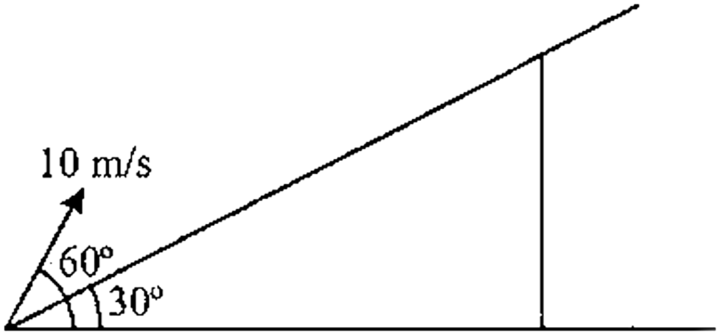
C. $\frac{3\sqrt{3}}{2}\frac{\omega R}{\pi}$

D. $\frac{2}{3}\frac{\omega R}{\pi}$

Answer: C

Watch Video Solution

101. A particle is thrown at time $t = 0$ with a velocity of 10 m/s at an angle of 60° with the horizontal from a point on an incline plane, making an angle of 30° with the horizontal. The time when the velocity of the projectile becomes parallel to the incline is :



A. $\frac{2}{\sqrt{3}}$ sec

B. $\frac{1}{\sqrt{3}}$ sec

C. $\sqrt{3}$ sec

D. $\frac{1}{2\sqrt{3}}$ sec

Answer: B

Watch Video Solution

102. A particle is moving along the path given by $y = \frac{C}{6}t^6$ (where C is a positive constant). The relation between the acceleration (a) and the velocity (v) of the particle at $t = 5\,\mathrm{sec}$ is

A. $5a = v$

B. $a = 5v$

C. $a = \sqrt{v}$

D. $a = v$

Answer: D

Watch Video Solution

103. Three particles are projected in air with the minimum possible speeds, such that the first goes from Ato B, the second goes from 5 to C and the third goes from C to A. Points A and C are at the same vertical level. The two inclines make the same angle a with the horizontal as shown. Thenthe relation among the projection speeds of the three particles is :

A. $u_3 = u_1 + u_2$

B. $u_3^2 = 2u_1u_2$

C. $\frac{1}{u_3} = \frac{1}{u_1} + \frac{1}{u_2}$

D. $u_3^2 = u_1^2 + u_2^2$

Answer: B

View Text Solution

104. A particle moving in the positive x-direction has initial velocity v_0. The particle undergoes retardation kv^2 , where vis its instantaneous velocity. The velocity of the particle as a function of time is given by:

A. $v = v_0 / (1 + kv_0 t)$

B. $v = \dfrac{2v_0}{1 + kt}$

C. $v = \dfrac{v_0}{kt}$

D. $v = \dfrac{v_0}{(1 + k^2 v_0^2 t)}$

Answer: A

Watch Video Solution

105. A particles is projected with speed u at an angle θ with horizontal particle explodes at highest point of its path into two equal fragments one of fragment moving up straight with a speed u. The difference in time in which the particles fall on ground. (Assume it explodes at maximum height H)

A. $\frac{2u}{g}$

B. $\frac{u}{g}\sqrt{u^2 - 2gH}$

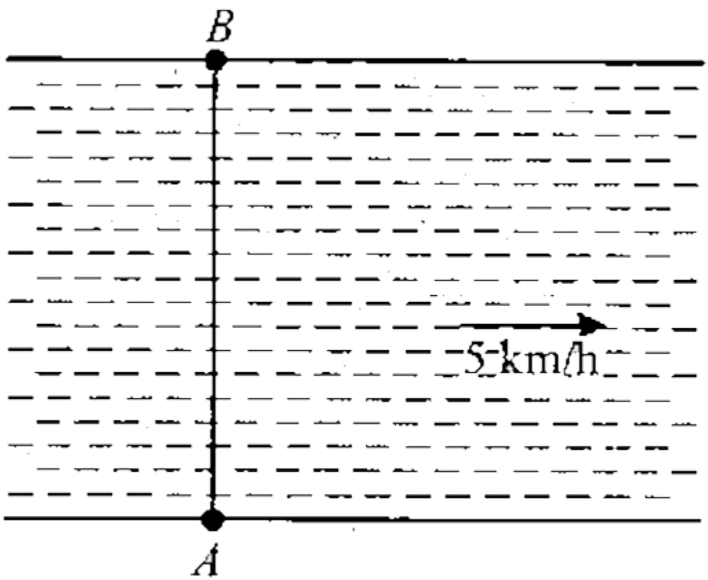
C. $\frac{1}{2g}\sqrt{u^2 + 2gH}$

D. $\frac{2}{g}\sqrt{u^2 + 2gH}$

Answer: A

Watch Video Solution

106. Inthe figure shown a river of width 4km is flowing with the speed of 5km/h. A swimmer whose swimming speed relative to the water is 4km/h, starts swimming from a points on a bank. On the other bank 5 is a point which is directly opposite to A. What minimum distance (in km) the swimmer will have to walk on the other bank to reach the point B.



A. 2

B. 3

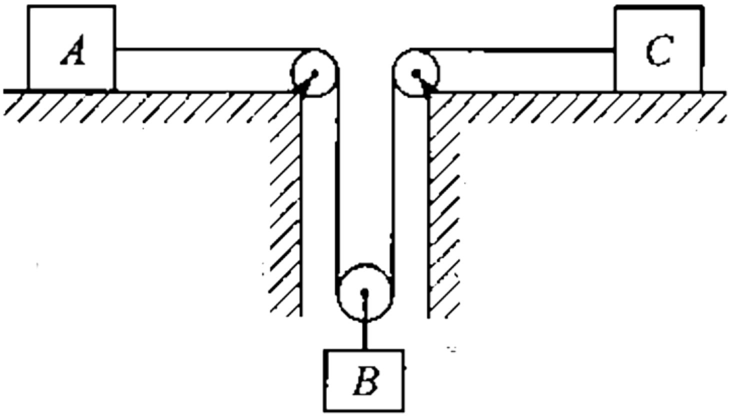
C. 4

D. 5

Answer: B

Watch Video Solution

107. If block A starts from rest at $t = 0$ & begins to move towards right with $2m/s^2$ & simultaneously C moves towards right with constant velocity of 4 m/s. Velocity of block B at $t = 5$ sec. will be:



A. 2 m/s

B. 3 m/s

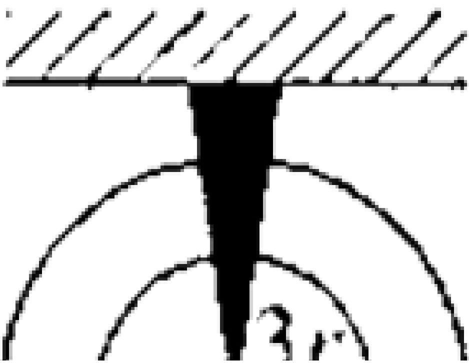
C. 4 m/s

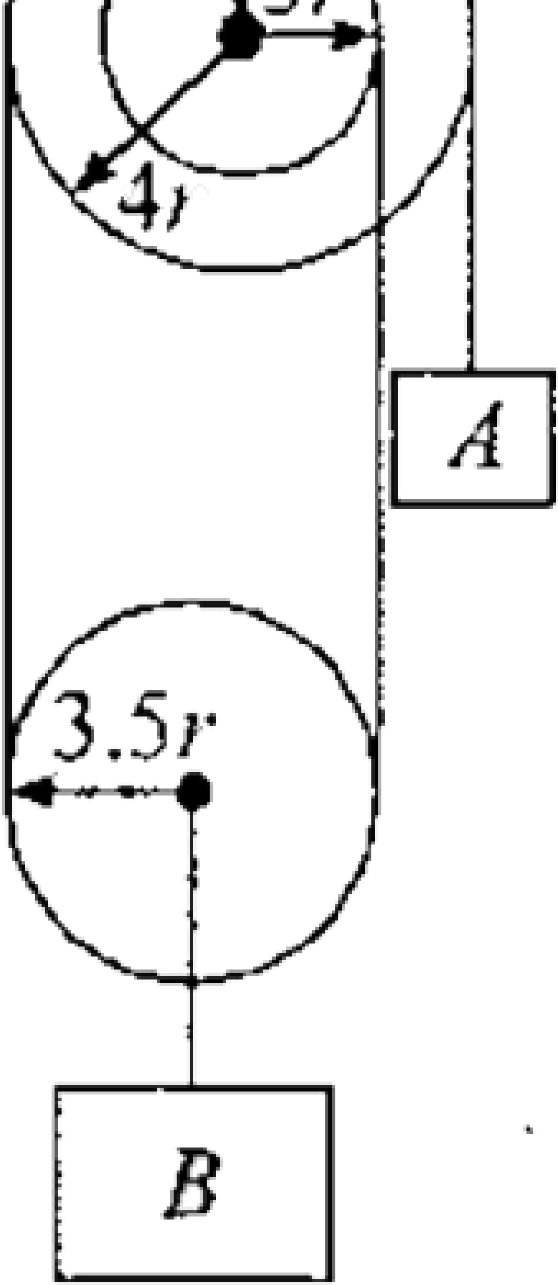
D. None

Answer: B

Watch Video Solution

108. In the pulley system shown the two upper pulleys are fastened together to form single unit. The cable is wrapped around the smaller pulley with its end secured to the pulleys so that it cannot slip. Determine the upward acceleration of block B if A has downward acceleration of $2m/s^2$:





A. $16m/s^2$

B. $8m/s^2$

C. $0.5m/s^2$

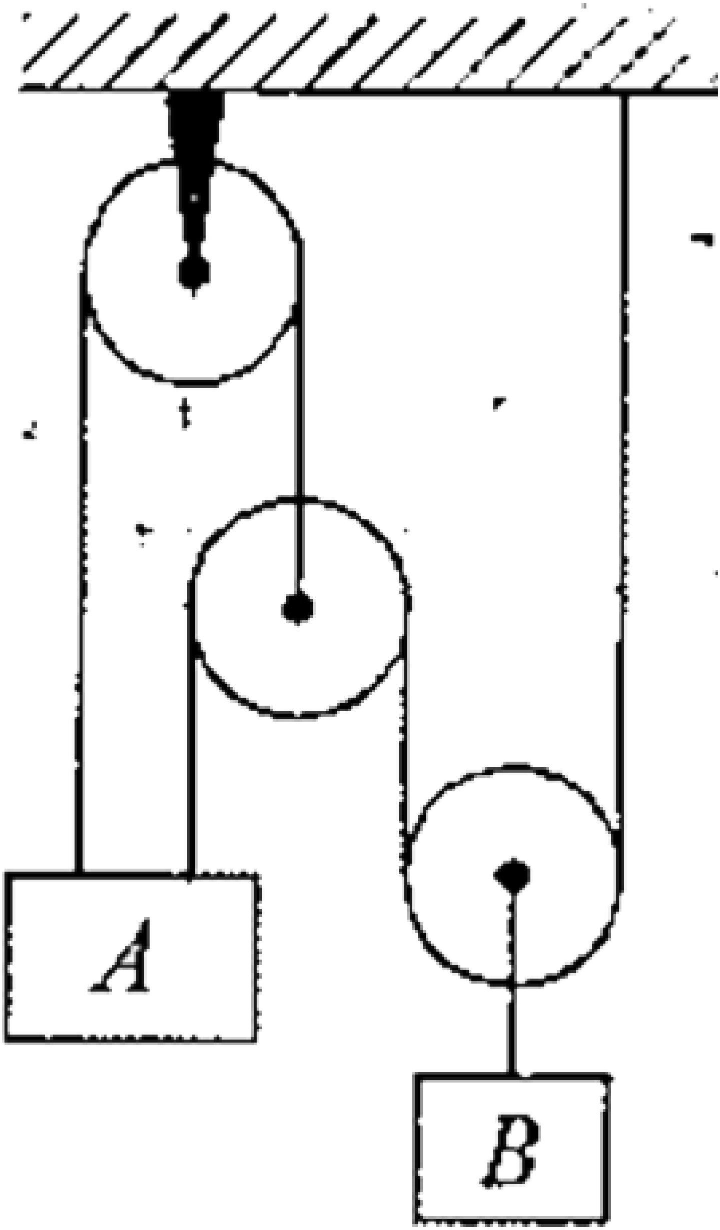
D. $0.25m/s^2$

Answer: D

Watch Video Solution

109. Knowing that block B starts to move downward with a constant velocity of

18cm/sec, the velocity of block A will be:



A. 27 cm/s

B. 12 cm/s

C. 36 cm/s

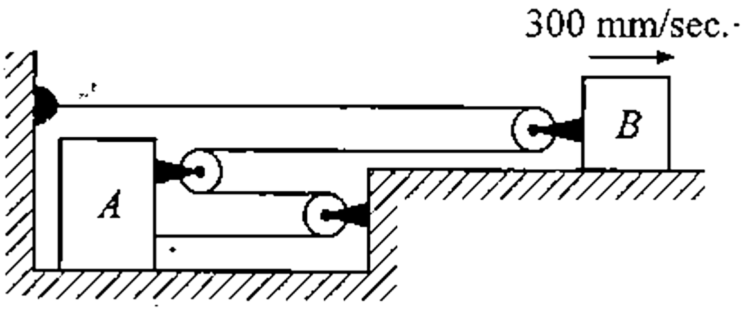
D. 9 cm/s

Answer: B

Watch Video Solution

110. If velocity of block B in the given arrangement is 300mm/sec. towards right.

Then velocity of A will be :



A. 200 mm/sec

B. 100 mm/sec

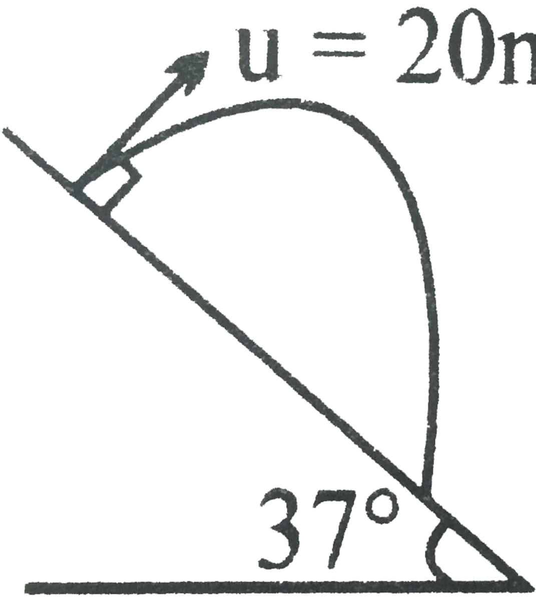
C. 450 mm/sec

D. 150 mm/sec

Answer: A

Watch Video Solution

111. Find range of projectile on the inclined plane which is projected perpendicular to the incline plane with velcoity $20m / s$ as shwon in figure.



A. 75 m

B. 40 m

C. 45 m

D. 50 m

Answer: A

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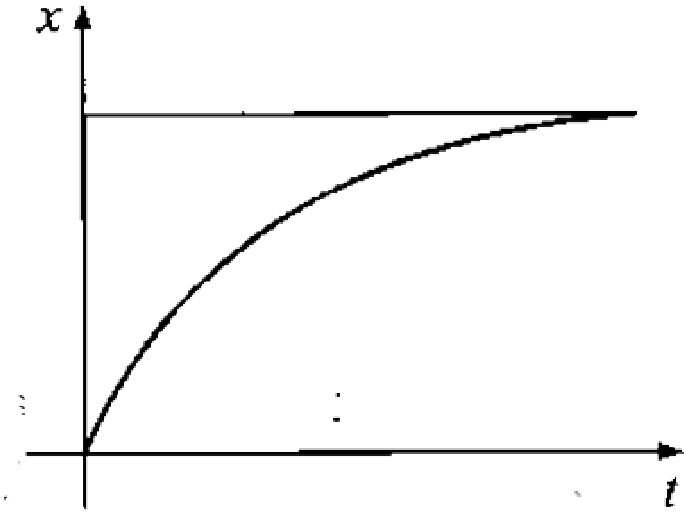
Advance Mcqs With One Or More Options Correct

1. Thedisplacement xofaparticle asa function oftime t si shown in following figure -1.148. The figure indicates:



A. The particle starts with a certain velocity, but the motion is retarded and finally particle stops

B. The velocity ofparticle is constant through out

C. The acceleration oftheparticleisconstant throughout

D. The particle starts with a constant velocity, the motion is accelerated:

Answer: A

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2. A particle is projected vertically upward with velocity u from a point A, when it returns to the point of projection .

A. Its average velocity is zero

B. Its displacement is zero

C. Its average speed is $u/2$

D. Its average speed is u

Answer: A, B, C

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3. An object may have :-

A. Varying speed without having varying velocity,

B. Varying velocity without having varying speed,

C. Non zero acceleration without having varying velocity,

D. Non zero acceleration without having varying speed.

Answer: B, D

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4. Choose the correct statement(s):

A. We can have a motion having zero displacement and nonzero average speed.

B. Average velocity is half the sum of its initial and final velocity.

C. Total displacement is equal to product of average velocity and time.

D. Acceleration of a particle is positive if it is moving in negative direction with decreasing speed.

Answer: A, C, D

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5. Choose the correct statement(s):

A. If a particle moving in a straight line has a negative acceleration then this always meant that the speed is decreasing.

B. If speed of a particle moving in straight line changes, it must have non-zero acceleration.

C. Acceleration of a particle is negative if it is moving in +ve direction with decreasing speed.

D. Rate of change of speed is magnitude of acceleration at any instant.

Answer: B, C

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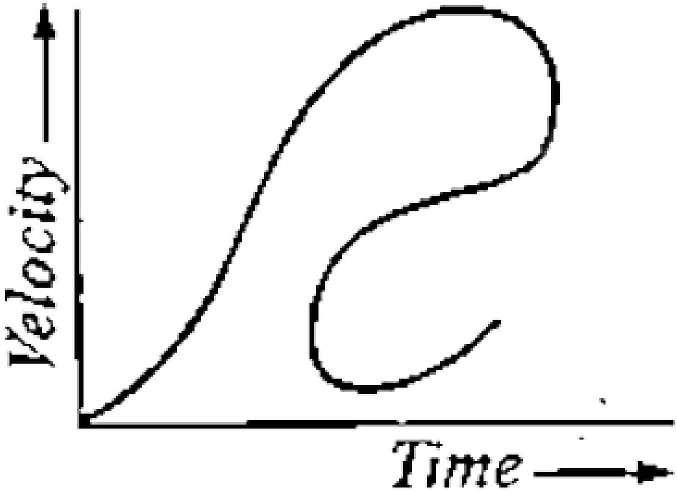
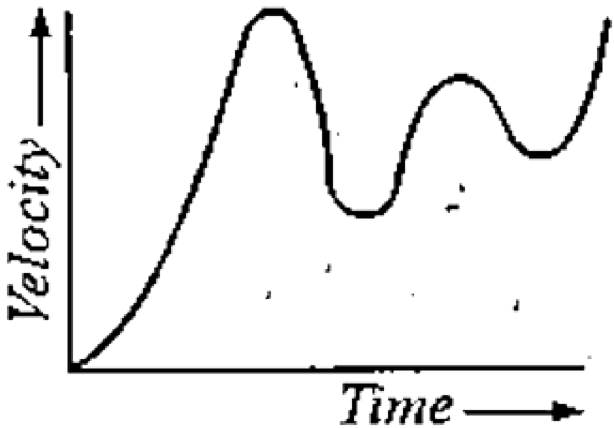
6. Figure shows some velocity versus time graphs :



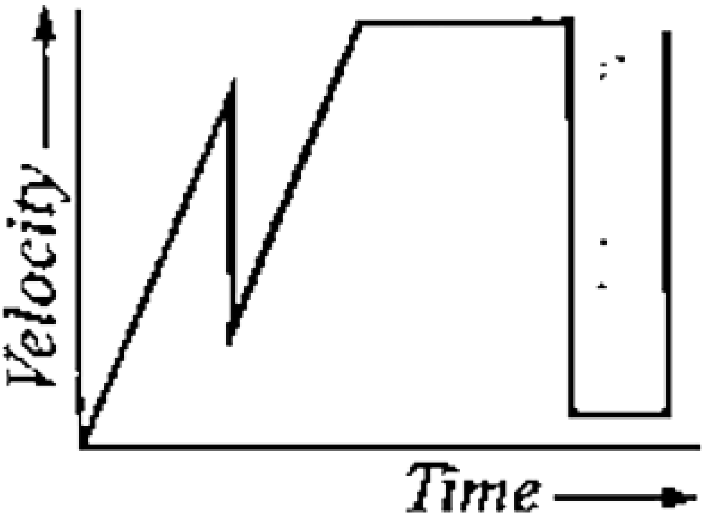
(a)

,



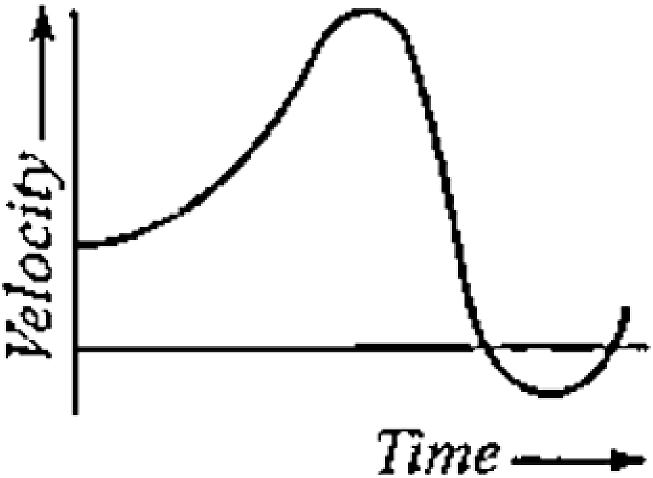
(b)

,



(c)

,



(d)

Only some of these can be realised in practice.These are:

A. Figure-(a)

B. Figure-(b)

C. Figure-(c)

D. Figure-(d)

Answer: B, D

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7. A man is running with a constant acceleration on a plank which is placed on a horizontal smooth surface. Then choose the correct option(s):

A. Work done by friction on the man is negative

B. Work done by friction on the man is positive

C. Work done by friction on the plank is positive

D. Work done by friction on the plank is negative

Answer: B, C

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8. Man A is sitting in a car moving with a speed of 54 $\frac{km}{hr}$ observes a man B in front of the car crossing perpendicularly a road of width 15 m in three seconds. Then the velocity of man B (in $\frac{m}{s}$) will be:

A. Speed of man B is $5\sqrt{10}$ m/s

B. Speed of man B is $5ms^{-1}$

C. Actual direction of motion of B is at an angle of $\tan^{-1}\left(\frac{1}{3}\right)$ with direction of motion of car

D. Actual direction of motion of B si at angle of $\tan^{-1}(3)$ with direction opposite to the direction of motion of car

Answer: A, C

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9. A motor boat is to reach to a point 30° upstream on other side of a river flowing with velocity $5m/s$.Velocity of motor boat with respect to water is $5\sqrt{3}m/\text{sec}$.The driver should steer the boat at an angle of

A. 30° up w.r.t. the line of destination from the starting point

B. 60° up w.r.t. normal to the bank

C. 120° w.r.t. stream direction

D. None of these

Answer: A, B, C

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10. The position of a particle moving in a straight line is given by

$x = 3t^3 - 18t^2 + 36t$

Here, x is in m and t in second. Then

A. direction of velocity and acceleration both change at $t = 2s$

B. the distance travelled by particle is equal to magnitude of displacement for $t = 0$ to $t = 5s$

C. the speed of particle is decreasing in $t = 0$ to $t = 2s$ then it is increasing for $t > 2$

D. The magnitudes of velocity and acceleration are equal at $t = 0$

Answer: B, C, D

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11. A particle is projected at an angle $\theta = 30^\circ$ with the horizontal, with a velocity of $10ms^{-1}$. Then

A. after 2 s the velocity of particle makes an angle of 60° with initial velocity vector

B. after 1s the velocity of particle makes an angle of 60° with initial velocity vector

C. the magnitude of velocity of particle after 1s is 10m/s

D. the magnitude of velocity of particle after 1s is 5m/s

Answer: B, C

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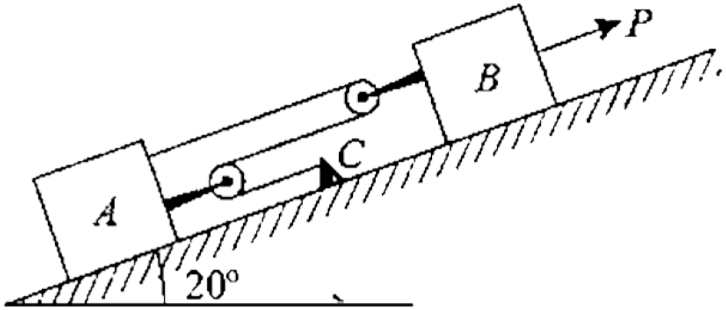
12. Under the action of force P, the constant acceleration of block B is $6m/\sec^2$ up the incline. For the instant when the velocity of B is $3m/\sec$ up the incline. Choose the correct option(s)



A. Velocity of B relative to A is 1 m/s

B. Acceleration of B relative to A is $2m/s^2$

C. The velocity of point C of the cable (in ground frame) is 4 m/s

D. Velocity of B relative to A is 2 m/s

Answer: A, B, C

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13. A particle moves with constant speed v along a regular hexagon $ABCDEF$ in the same order. Then the magnitude of the avergae velocity for its motion form A to

A. F is $v/5$

B. D is $v/3$

C. C is $v\sqrt{3}/2$

D. B is v

Answer: A, C, D

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14. A particle has initial velcoity $10m/s$. It moves due to constant retarding force along the line of velocity which produces a retardation of $5m/s^2$. Then

A. The maximum displacement in the direction of initial velocity is 10 m

B. The distance travelled in first 3 seconds is 7.5 m

C. The distance travelled in first 3 seconds is 12.5 m

D. The distance travelled in first 3 seconds is 17.5 m.

Answer: A, C

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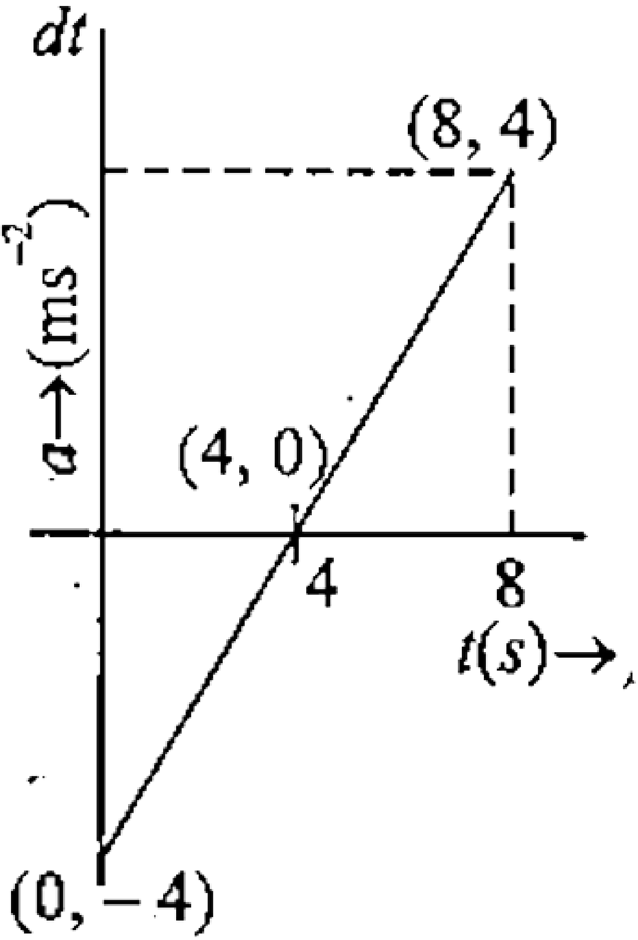
15. If a particle is moving along a straight line and following is the graph showing acceleration varying with time then choose correct statement(s). At $t = 0, x = 0$ and

$v_0 = 7ms^{-1}$



A. Its displacement can never become zero

B. Its velocity can never become zero

C. Its displacement can become zero

D. Its velocity can become zero

Answer: A, D

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16. a particle moving along a straight line with uniform acceleration has velocities $7m/s$ at A and $17m/s$ at C. B is the mid point of AC. Then :-

A. The velocity at B is $12m/s$

B. The average velocity between A and B is 10 m/s

C. The ratio of the time to go from A to B to that from B to C is $3:2$

D. The average velocity between B and C is 15m/s

Answer: B, C, D

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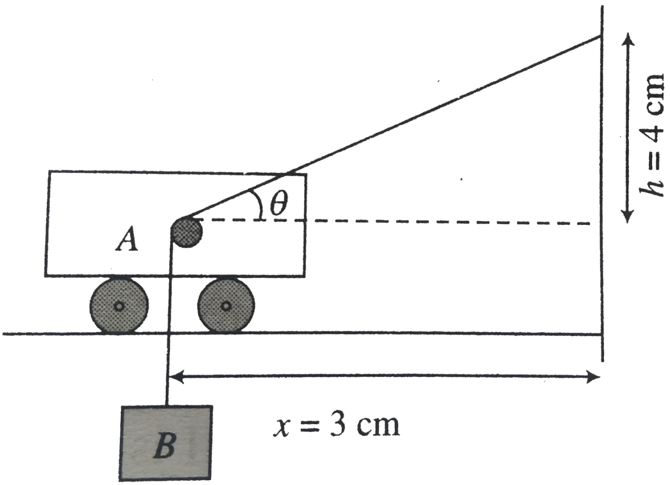
17. The string in fig. is passing over small smooth pulley rigidly attached to trolley A. If the speed of trolley is constant and qual to v_A towards right, speed and magnitude of acceleration of block B at the instant shown in figure are



A. $V_B = V_A, a_B = 0$

B. $a_B = 0$

C. $a_B = \frac{3}{5}v_A$

D. $a_B = \frac{16v_A^2}{125}$

Answer: C, D

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Unsolved Numerical Pro

1. A ball is released from rest. If it takes 1 second to cross the last 20 m before hitting the ground, find the height from which it was dropped.

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2. The accelerator of a train can produce a uniform acceleration of $0.25ms^{-2}$ and its brake can produce a retardation of $0.5ms^{-2}$ The shortest time in which the train can travel between two stations 8 km apart is x minutes and 10 s, if it stops at both stations. The value of x is.

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3. All insect is moving on a groove whose displacement is given $x = 6t^2 - 8 + 40. \cos \pi t,$, where x and t are expressed in metres and seconds. Find the position, velocity and acceleration of insect at time t = 6 s.

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4. Two cars, A and B, are traveling in the same direction with velocities v_a and v_b respectively. When car is at a distance d behind car B, the brakes on A are applied, causing a deceleration at a rate a. Show that to prevent a collision between A and B it is necessary that:

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5. A motor boat starts from rest with an acceleration given by the law $a = \frac{c}{(x+4)^2}$ where c is a positive constant. Given that the velocity of the boat when its displacement is $8m$ is $4m/s$. Find:

(a) The magnitude of c .

(b) The position of the boat when its speed was 4.5 m/s.

(c) The maximum velocity of the boat.

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6. The acceleration of a particle is given by the relation as $a = -kv^{5/2}$, where is a constant. The particle starts at x=0 with a velocity of 16 m/s, and when x = 6, the velocity is observed to be 4 m/s. Find the velocity of particle when x=5m and the time at which the velocity ofthe particle is 9 m/s.

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7. In a given steam jet, the velocity of the steam at the mouth of jet is $V_0 = 3.6m/s$.

The velocity of the steam at a distance x from jet is given as $v = \frac{0.18v_0}{x}$. Find the acceleration of the air at X=2 m and the time required for the air to flow from x = 1m to x = 3m

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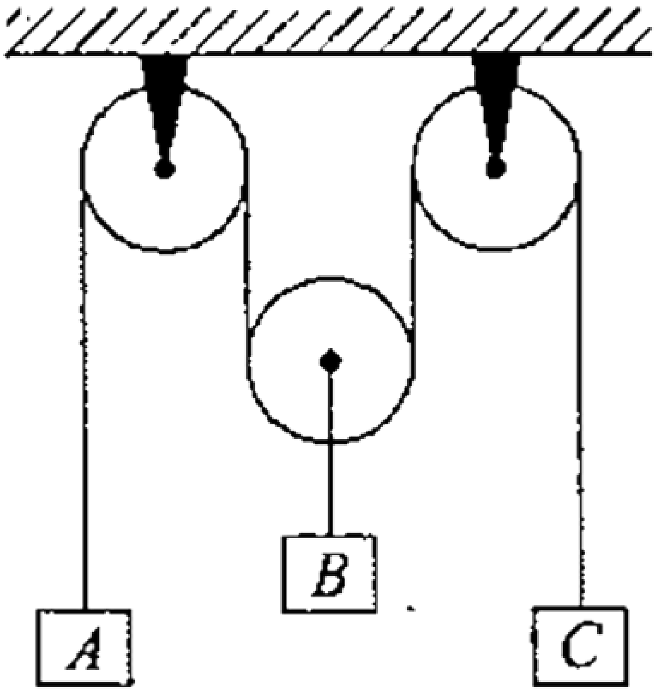
8. Figure shows three blocks A, B and C connected by a cable and system of pulleys. The blocks is pulled downward with a constant velocity of $7.5cm/s$. At t = 0 , block, A starts moving downward from rest with a constant acceleration. It is given that the velocity of block A after travelling 20 cm is 30cm/s, find the change in position, velocity and the acceleration of block C at this instant.



9. A traffic police officer observes a fast moving car. Due to over speed officer starts his bike, accelerates uniformly to 90 kph in 8 s, and maintaining a constant velocity of 90 kph, overtakes the car 42 s after the car passed him. If he overtakes the carafter 18 s from the instant he starts, find the distance the officer travelled before overtaking and the speed of car.

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10. A steel ball is dropped from the roof of a building. A man standing in front of a $1-m$ high window in the building notes the the ball takes $0.1s$ to the fall from the top to the bottom of the window. The ball continues to fall and strikes the ground. On striking the ground, the ball gets rebounded with the same speed with which it hits the ground. If the ball reappears at the bottom of the window $2s$ after passing the bottom of the window on the way down, find the height of the building.

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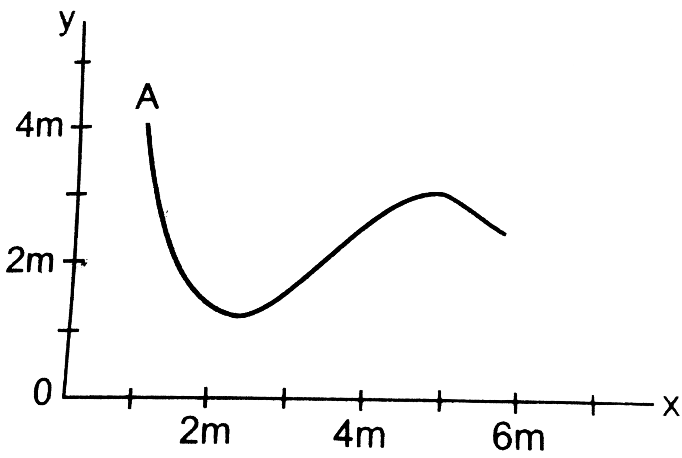
11. A particle starts from a pointn A and travels along the solid curve shown in figure. Find approximately the position B of the particle such that the average velocity between the positions A and B has the same direction as the instantaneous velocity at B.



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12. A car starts moving along a line, first with acceleration a=5 ms^{-2} starting from rest then uniformly and finally decelerating at the same rate a, comes to rest.The total time of motion

is $\tau = 25s$. The average velocity during the time is equal to lt v gt =72 km/hr.How long does the partial move uniformly ?

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13. In a motorcycle race, a rider A is leading another rider B by 36 m and both riders are travelling at a constant speed of 170 kph. At t=0 both starts accelerating at a constantrate. It is given that after 8s, So vertakes And at this

instant speed of A is 220 kph. Find the accelerations of the two riders

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14. Two friends A and B are standing a distance x apart in an open field and wind is blowing in a direction perpendicular to .the line joining AB. A beats a drum and finds a time lag between seeing and hearing the drum beating by A. Find this time lag.

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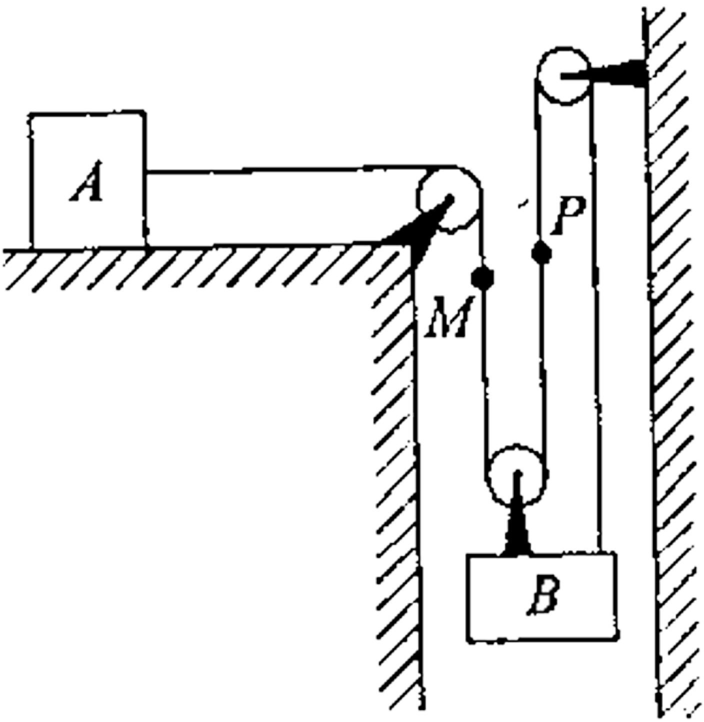
15. Two blocks A and B are shown in figure. Block A moves to the left with a constant velocity of 6m/s. Find :



(a) Velocity of the blocks B.

(b) Velocity of the point P of the string.

Relative velocity of the point M of the cable with respect to the point P.

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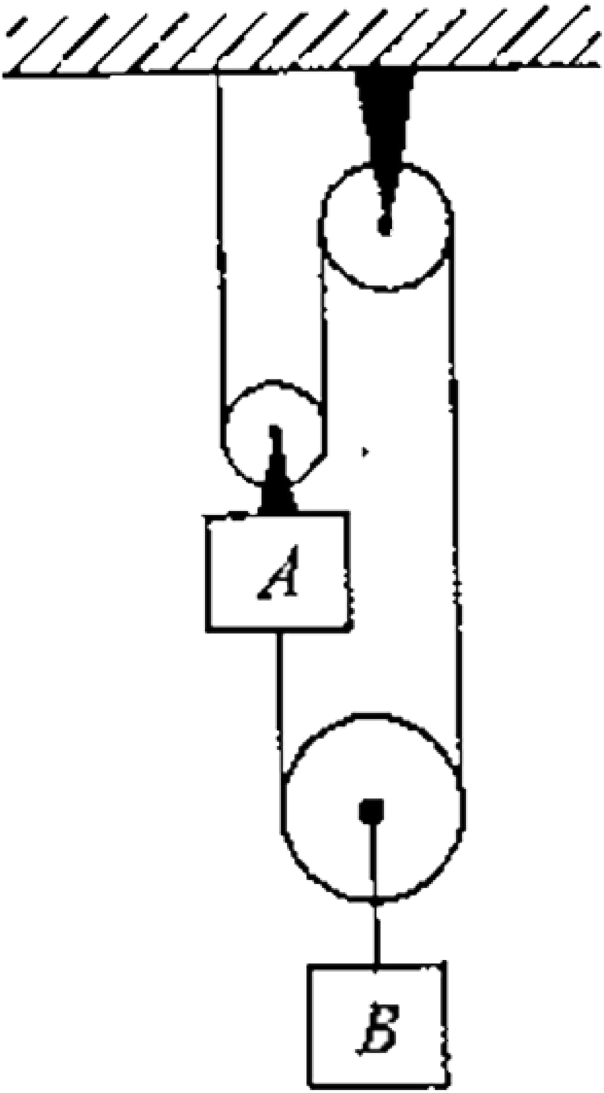
16. In figure block A starts from rest and moves upward with a constant acceleration. After 8 s the relative velocity of block B with respect to A is 0.6 m/s. Find the accelerations of blocks A and B. Also find the velocity of block B after 6 s.



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17. A man of height 1.2 m walks away from a lamp hanging at a height of 4.0 m above ground level. If the man walks with a speed of $2.8m/s$, determine the speed of the tip of man's shadow.

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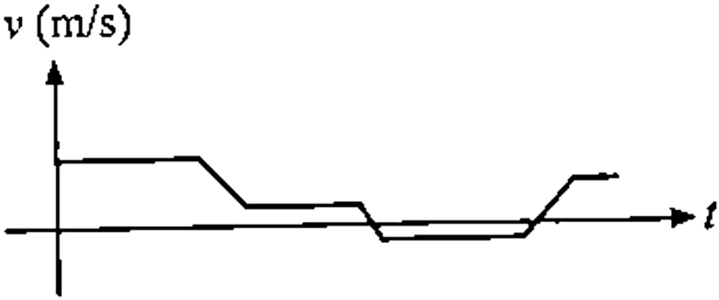
18. A particle moves in a straight line with the velocity curve shown in figure. Draw approximate acceleration vs time and displacement vs time curves. Consider x=0 at $t = 0$.



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19. A point mass starts moving in a straight line with a constant acceleration a. At a time t_1 a fter the beginning of motion, the acceleration changes sign, remaining the same

in magnitude. Determine the time t from the beginning of motion in which the point mass returns to the initial position.

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20. A car C_1 travelling at a uniform speed of 75 kph passed another C_2 car at rest beside the track. Two minutes later C_2 starts and accelerates uniformly until its speed increases to 100 kph, then it maintains the speed. After 12 minutes from the instant C_1 passes C_2, C_2

is 800 m ahead of C_1. Find when and where C_2 overtakes C_1 and the acceleration of C_2.

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21. A helicopter takes off along the vertical with an acceleration $a = 3m/s^2$ and zero initial velocity. In a certain time the pilot switches off the engine. At the point of take off, the sound dies away in a time $t_2 = 30\,\text{sec}$. Determine the velocity of the helicopter at the moment when its engine is switched off assuming that velocity of sound is 320 m/s.

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22. Two trucks are moving in a straight line towards each other at initial velocities u_1 and u_2 and with constant retardations a_1 and a_2. If the initial separation between them is d, find the minimum value of d for no collision.

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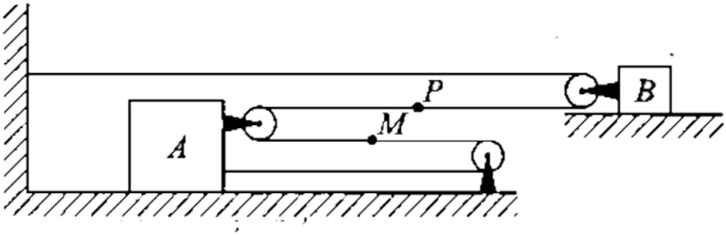
23. Block 5 shown in figure moves to the right with a constant velocity of 30 cm/s. Find :



(a) The velocity of block A.

(b) The velocity of the point P of the string.

(c) The velocity of the point M of the string.

(d) The relative velocity of the point P of the string with respect to the block A.

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24. At t = 0, block B in figure starts moving with a velocity 15 cm/s and with a constant acceleration. It is observed that after blocks travels 24 cm to the right its velocity is 6cm/s. Find:

(a) The accelerations of A and B,

(b) The acceleration of point M of the string.

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25. A stone is dropped from the top of a cliff of height h. "n" seconds later, a second stone is projected downwards from the same cliff with a vertically downward velocity u. Show that the two stones will reach the bottom of the cliff together, if

$$8h(u - gn)^2 = gn^2(2u - gn)^2$$

what can you say about the limiting value of "n" ?

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26. How long will a plane take to fly around a square with side a with the wind blowing at a velocity u, in the two cases (a) the direction of the wind coincides with one of the sides (b) the direction of the wind coincides with one diagonal of the square. The velocity of the plane in still air is $v > u$..

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27. The motion of an in secton at able is given as $x = 4t - 2\sin t$ and $y = A - 1\cos t$, where x and y are in metres and t is in seconds. Find the magnitude of minimum and maximum velocities attained by the insect.

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28. Two motor cars start from A simultaneously & reach B after 2 hour. The first car travelled half the distance at a speed of $v_1 = 30kmhr^{-1}$ & the other half at a speed of $v_2 = 60kmhr^{-1}$. The second car covered the entire with a constant acceleration. At what instant of time, were the speeds of both the vehicles same? Will one of them overtake the other enroute?

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29. A body of mass m is thrown straight up with a velocity Mq. Find the velocity u' with which the body comes down if the air drag equals cu^2 where c is a constant and u is the velocity of the body.

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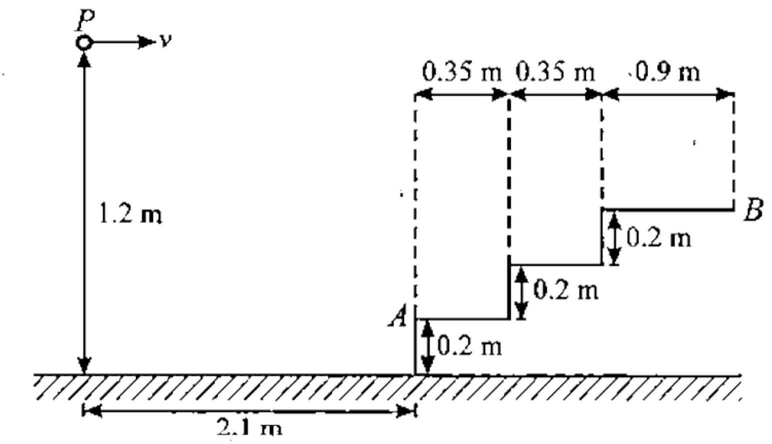
30. In a village Shyam bats for hitting two points A and B on a staircase with his goli from the position P shown in figure. Find the velocities required for P to hit A and B.



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31. A ship moves along the equator to the east with velocity $v_0 = 30 km / hour$. The southeastern wind blows at an angle $\varphi = 60^\circ$ to the equator with velocity $v = 15 km / hour$. Find the wind velocity v' relative to the ship and the angle of φ' between the equator and the wind direction in the reference frame fixed to the ship.

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32. Point A moves uniformly with velocity ν so that the vector v is continually "aimed" at point B which in its turn moves rectilinearly and uniformly with velocity $v < \nu$. At the initial moment of time $v \perp u$ and the points are separated by a distance l. How soon will the points converge?

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33. The speed of a train increases at a constant rate α from zero to v and then remains constant for an interval and finally decreases to zero at a constant rate β. The total distance travelled by the train is l. The time taken to complete the journey is t. Then,

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34. The position vector $\vec{r}$ of a moving particle at time t after the start of the motion is given by $\overrightarrow{r} = (5 + 20t)\hat{i} + (95 + 10t - 5t^2)\hat{j}$. At the t = T, the particle is moving at right angles to its initial direction of motion. Find the value of T and the distance of the particle from its initial position at this time.

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35. On a cricket field, the batsman is at the origin of coordination and a fielder stands in position given as $\left(46\hat{i} + 28\hat{j}\right)m$. The batsman hits the ball so that it rolls along the ground with constant velocity given $\left(7.5\hat{i} + 10\hat{j}\right)m/s$. The fielder can run with a speed of $5m/s$. If the starts to run immediately the ball is hit, what is the shortest time in which he could intercept the ball.

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36. Two steel balls fall freely on an elastic slab. The first ball is dropped from a height h_1 and the second from a height $h_2(h_2 < h_1)\text{sec}$

after the first ball. After the passage of time T, the velocities of the balls coincide in magnitude and direction. Determine the time T and the time interval during which the velocities of the two balls will be equal assuming that the balls do not collide.

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37. A motor boat, with its engine on in a running river and blow n over by a horizontal wind is observed to travelat 20 kph in a direction 53° East of North. The velocity of the boat with its engine on in still water & blown over by the horizontal wind is 4kph East ward and the velocity of the boat with its engine on over the running river, in the absence of wind is 8 kph due south. Find:

(a) The velocity of the boat in magnitude and direction, over still water in the absence of wind.

(b) The velocity of the wind in magnitude and direction.

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38. A particle moves from rest in a straight line with alternate acceleration and retardation of mahnitudes f and f' during equal intervals of time t. At the end of $2n$ such intervals prove that the space it has described is

$$\frac{nt^2}{2}[(2n+1)f-(2n-1)f']$$

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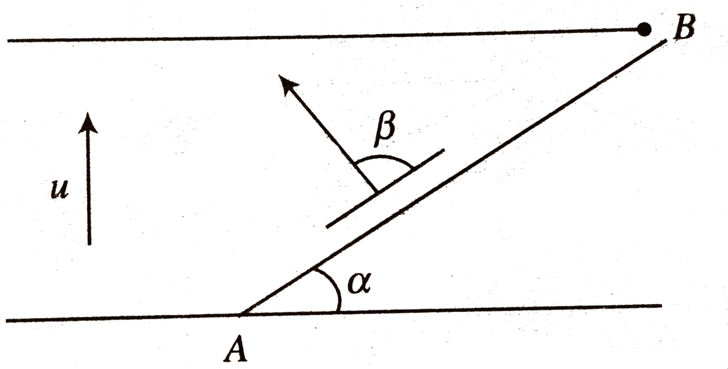
39. A launch travels across a river from a point A to a point B of the opposite bank along the

line AB forming angle $\propto$ with the bank. The flag on the mast of the launch makes an angle β with its direction of motion. Determine the speed of the launch w.r.t. the bank. The velocity of wind is u perpendicular to the stream.



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40. A particle moves for total time T sec in a straight line in three consecutive parts such that its acceleration during the first, second and third parts is in the ratio 1:2:7. The distances covered in the first and the third parts are a and b meters while the time taken for each of the is tseconds. Find the average velocity of the particle during the second part.

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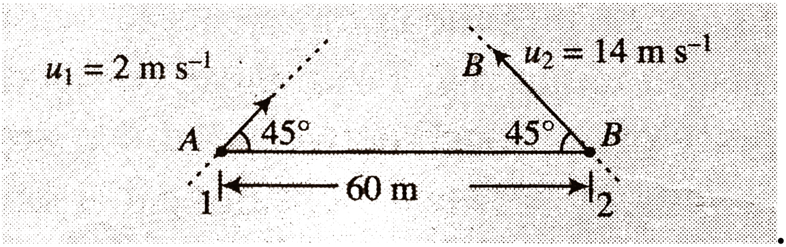
41. Two particles are located on a horizontal plane at a distance $60m$. At $t=0$ both the particles are simultaneously projected at angle 45° with velocities $2ms^{-1}$ and $14ms^{-1}$, respectively. Find

(a) Minimum separation between them during motion.

(b) At what time is the separation between them minimum ?



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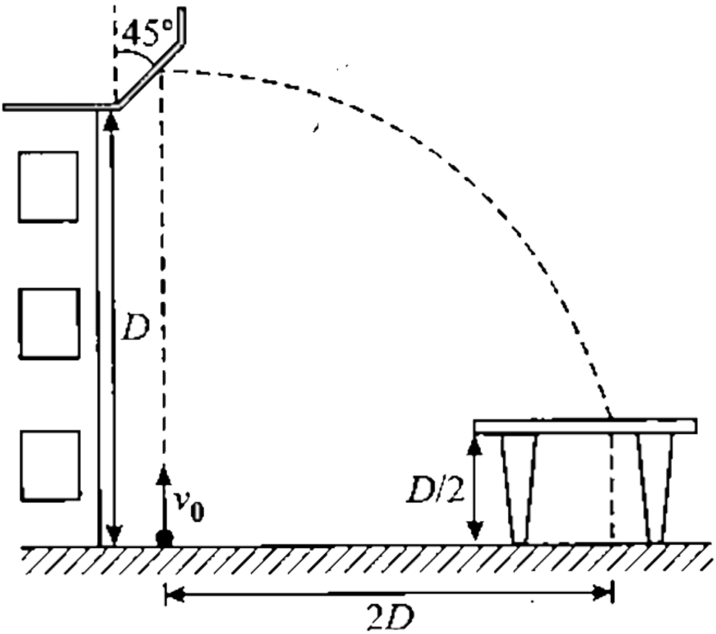
42. A ball is projected directly upward with an initial speed v_0. Bounces elastically from a roof inclined at an angle 45° as shown in figure and then it strikes a table at a horizontal distance 2D from its starting point. Find v_0.



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43. The current velocity of river grows in proportion to the distance from its bank and reaches the maximum value v_0 in the middle. Near the banks the velocity is zero. A boat is moving along the river in such a manner that the boatman rows his boat always perpendicular to the current. The speed of the boat in still water is u. Find the distance through which the boat crossing the river will be carried away by the current, if the width of the river is c. Also determine the trajectory of the boat.

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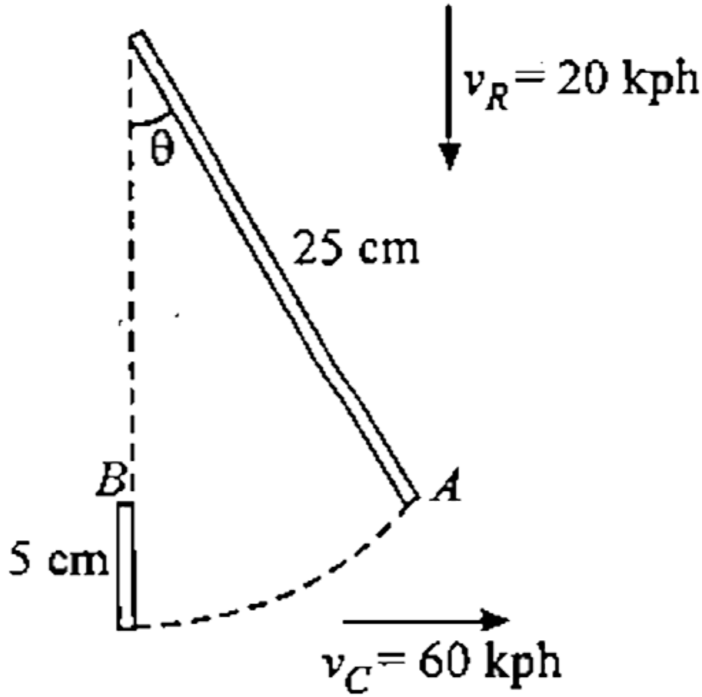
44. A vertical wind screen of a car is made up of two parts, as shown in figure, where the upper one A is 25cm vertically long and covers the 5cm of the lower piece B.The upper one is hinged at the top so that it can be opened outward, inclining to the vertical. The car is running on the horizontal road at 60km/hr in the rain which is falling vertically at 20km/hr. Find the maximum angle, through which the upper part A can be opened outward, such that the rain drops do not enter the car.



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45. A hunter is riding an elephant of height $4m$ moving in straight line with uniform speed

of $2m/\sec$. A deer running with a speed V in front at a distance of $4\sqrt{5}$ moving perpendicular to the direction of motion of the elephant. If hunter can throw his spear with a speed of $10m/\sec$. relative to the elephant, then at what angle θ to it's direction of motion must he throw his spear horizontally for a successful hit. Find also the speed 'V' of the deer.

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46. A swimmer wishes to cross a 500m wide river flowing at a rate 5km/hr. His speed with respect to water is 3km/hr. (a) If the heads in a direction making an angle θ with the flow, he takes to cross the river. (b) Find the shortest possible time to cross the river.

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47. Two particles, 1 and 2, move with constant velocities v_1 and v_2. At the initial moment their radius vectors are equal to r_1 and r_2. How must these four vectors be interrelated for the particles to collide?

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48. A ball is thrown from ground level so as to just clear a wall 4m high at a distance of 4 m and falls at a distance of 14 m from the wall. Find the magnitude and direction of the initial velocity.

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49. A bomber plane is moving horizontally in a straight line with speed 594 km//hour. When the fighter is 300 m behind, he fires guns which are then horizontal. If the bullets have a muzzle velocity of $3348 km / \text{hour}$ relative to the fighter at what distance below the line of slight and at what angle will the bullet hit the bomber ? Neglect air resistance and wind effects. Given that the velocity of the fighter plan is 720 km/hour.

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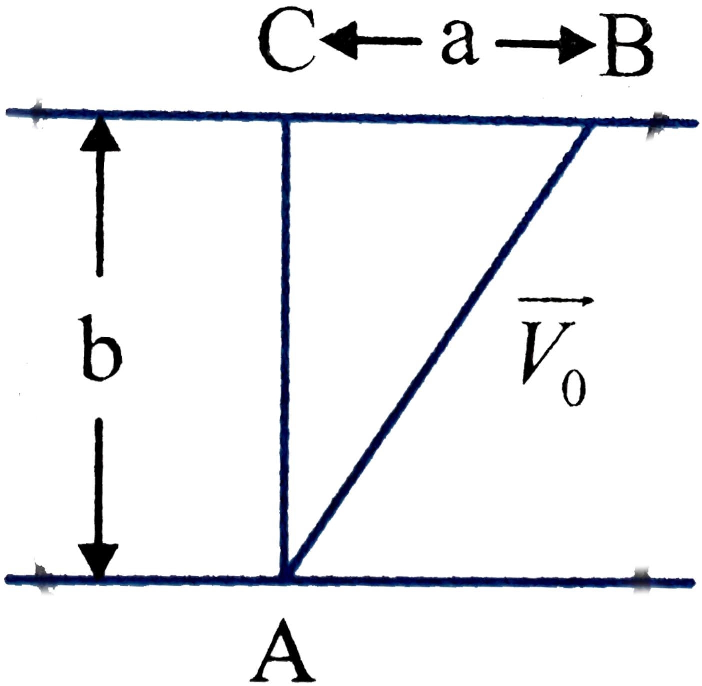
50. A man in a river boat must get from point A to point B on the opposite bank of the river (see figure).The distance $BC = a$.The width of the river $AC = b$.At what minimum speed u relative to the still water should the boat travel to reach the point B?The velocity of flow of the river is v_0



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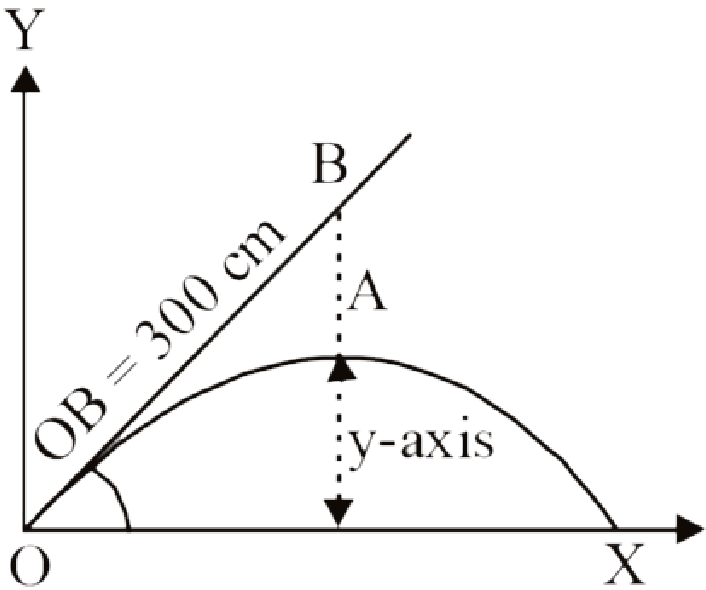
51. A ball 'A' is projected from origin with an initial velocity v_0 = 700 cm/sec in a direction 37° above the horizontal as shown in fig .Another ball 'B' 300 cm from origin on a line 37° above the horizontal is released from rest at the instant A starts. How far will B have fallen when it is hit by A ?



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52. An Aeroplane flies horizontaily at a height h at a speed v. An anti-air craft gun fires a shell at the plane when it is vertically above the gun. Show that the minimum muzzle velocity required to hit the plane is $\sqrt{v^2 + 2gh}$ at an angle $\tan^{-1}\left(\frac{\sqrt{2gh}}{v}\right)$

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53. A ball is projected at an angle of 30° above with the horizontal from the top of a tower ans strikes the ground in $5\,\text{sec}$ at angle of 45° with the horizontal. Find the hieght of the lower and the speede with which it was projected.

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54. Two boys simultaneously aim their guns at a bird sitting on a tower. The first boy releases his shot with a speed of 100m/s at an angle of projection of 30°. The second boy is ahead of the first by a distance of 50 m and releases his shot with a speed of 80m/s. How must he aim his gun so that both the shots hit the bird simultaneously ? What is the distance of the foot of the tower from the two boys and the height of the tower ? With what velocities and when do the two shots hit the bird?

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55. A boy throws a ball up ward with a speed of 12m/s The wind imparts a horizontal acceleration of $0.4m/s^2$. At what angle θ to the vertical, the ball must be thrown so that it returns to the point of release.

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56. A student is standing on the open platform of a moving trains at a speed of $10m/s$. The student throws a ball into the air along a path that the, he judges to make an initial angle of 60° with the horizotal and to be in line with the track. The professor, who is standing on the ground nearby, observes the ball to rise vertically. Find the height reached by the ball.

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57. 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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58. A particle moves in the plane x y with constant acceleration a directed along the negative y-axis. The equation of motion of the particle has the form $y = k_1 x - k_2 x^2$, where k_1 and k_2 are positive constants. Find the velocity of the particle at the origin of coordinates.

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59. A gardener shower jet is placed at a distance d from the wall of a building. If R is the maximum range of the jet that is produced when the bowl is connected to the nose of a fire engine, show that the portion of the wall that is hit by the jet of water is bounded by a parabola whose height is $\frac{(R^2 - d^2)}{2R}$ and breadth is $2\sqrt{R^2 - d^2}$.

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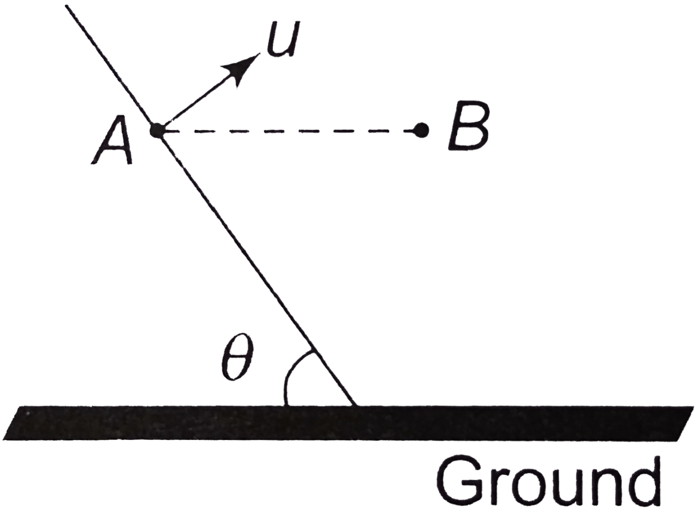
60. A particle is projected at point A from an inclination plane with inclination angle θ as shown in figure. The magnitude of projection velocity is $\vec{u}$ and its direction is perpendicular to the plane. After some time it passes from point B which is in the same horizontal level of A, with velocity $\vec{v}$. Then the angle between

$\overrightarrow{u}$ and $\overrightarrow{v}$ will be



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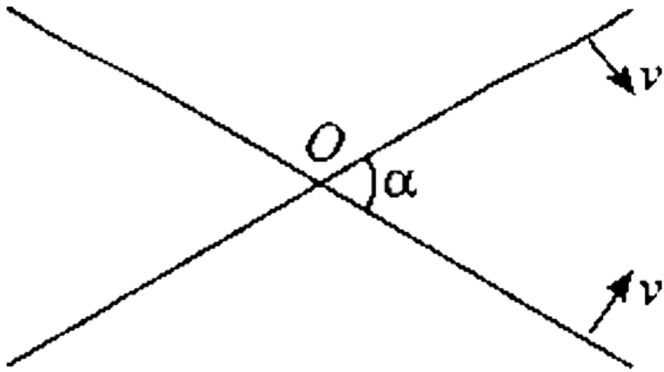
61. Two lines AB and CD intersect at O at an inclination α, as shown in figure. If they move out parallel to themselves with the speed v,

find the speed of O.



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62. A gun of muzzle speed v_0 is situated at height h above a horizontal plane. Prove that the angle at which it must be fired so as to achieve the greatest range on the plane is given by-

$$\theta = \frac{1}{2}\cos^{-1}\left(\frac{gh}{v_0^2 + gh}\right)$$

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63. A shell is fired from a gun from the bottom of a hill along its slope. The slope of the hill is $\propto = 30^\circ$ and the angle of the barrel to the horizontal $\beta = 60^\circ$. The initial velocity v of the shell is $21 ms^{-1}$. Then find the distance of point from the gun at which the shell will fall.

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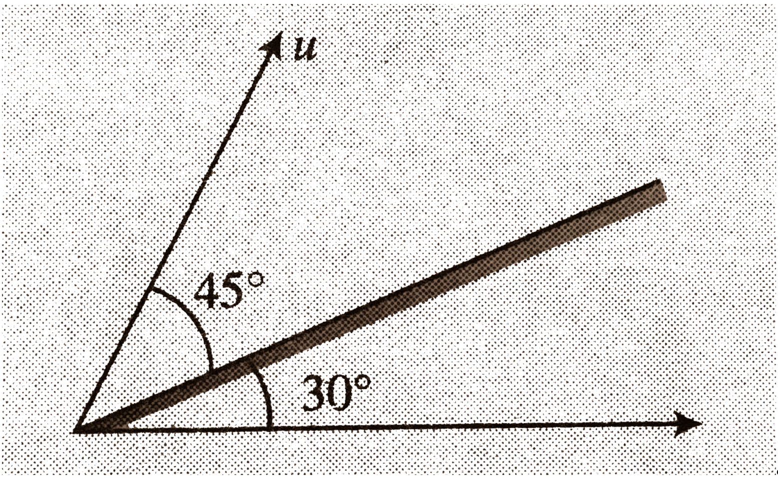
64. A particle is projected on an inclined plane with a speed u as shown in (Fig. 5.61). Find the range of the particle on the inclined plane.



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65. A projectile aimed at a mark, which is in the horizontal plane through the point of projection, falls a cm short of it when the elevation is α and goes b cm far when the elevation is β. Show that, if the speed of projection is same in all the cases the proper elevation is

$$\frac{1}{2}\sin^{-1}\left[\frac{b\sin 2\alpha + a\sin 2\beta}{a+b}\right].$$

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66. A boy sitting at the rear end of a railway compartment of a train, running at a constant acceleration on horizontal rails throws towards the fore end of the compartment with a muzzle velocity of 20m/sec at an angle 37° above the horizontal, when the train is running at a speed of 10 m/sec. If the same boy catches the ball without moving from his seat and at the same height of projection,find the speed of the train at the instant of his catching the ball.

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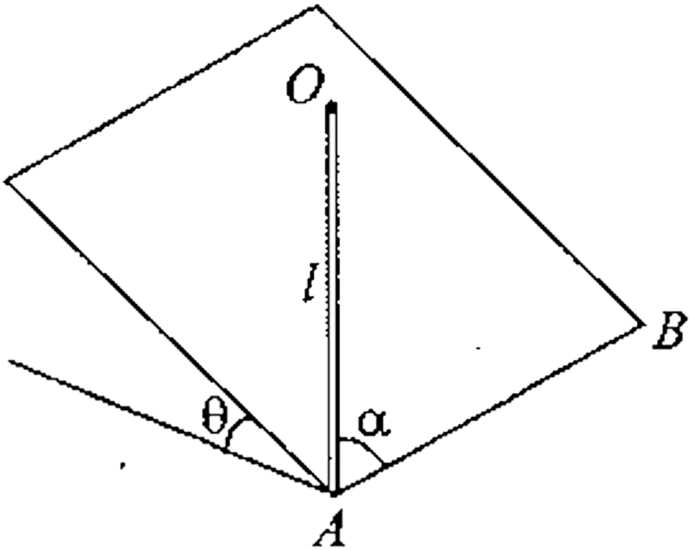
67. There is an inclined surface of inclination θ. A smooth groove is cut into it forming an angle α with AB as shown in figure. A steel ball is free to slide a long the groove. If the ball is released from the point O. Find the speed when it comes to A.



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68. To a person travelling due East with velocity u the wind appears to blow from an angle α North of East. When he starts travelling due North with velocity 2 u,the wind appears to blow from an angle β North of East. Find the true direction of the wind.

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69. A guided missile is fired to strike an object at the same level 38 km away. It may be assumed that it rises vertically 1.5 km and then for the remainder of the flight it follows a parabolic path at an elevation of 45° .

Calculate its velocity at the begining of its parabolic path.

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70. A train takes 2 minutes to acquire its full speed 60 kph from rest and 1 minute to come to rest from the full speed. If some where in between two stations 1 km of the track be under repair and the limited speed on this part be fixed to 20 kph, find the late running of the train on account of this repair work, assuming otherwise normal at running of the train between the stations.

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71. A stone is projected from the ground in such a direction so as to hit a bird on the top of a telegraph post of height h and attains the maximum height of 2h above the ground. If at the insatant of projection, the bird were to fly away horizontally with a uniform speed, find the ratio between the horizontal velocity of bird and the horizontal component of velocity of stone, if the stone hits the bird while descending.

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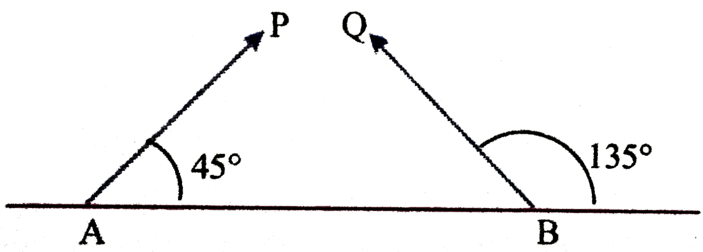
72. Particles P and Q of masses $20g$ and $40g$, respectively, are projected from positions A and B on the ground. The initial velocities of P and Q make angles of 45° and 135°, respectively with the horizontal as shown in the fig. Each particle has an initial speed of

$49m/s$. The separation AB is $245m$. Both particles travel in the same vertical plane and undergo a collision. After the collision P retraces its path. The separation of Q from its initial position when it hits the ground is



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73. Two shots are projected from a gun at the top of a hill with the same velocity u at angles of projection α and β respectively. If the shots strike the horizontal ground through the foot of the hill at the same point, show that the height h of the hill above the plane is given by :

$$h = \frac{2u^2(1 - \tan\alpha\tan\beta)}{g(\tan\alpha + \tan\beta)^2}$$

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74. A point moves in the plane xy according to the law $x = a\sin\omega t, y = a(1 - \cos\omega t)$, where a and ω are positive constants. Find:

(a) the distance s traversed by the point during the time τ,

(b) the angle between the point's velocity and acceleration vectors.

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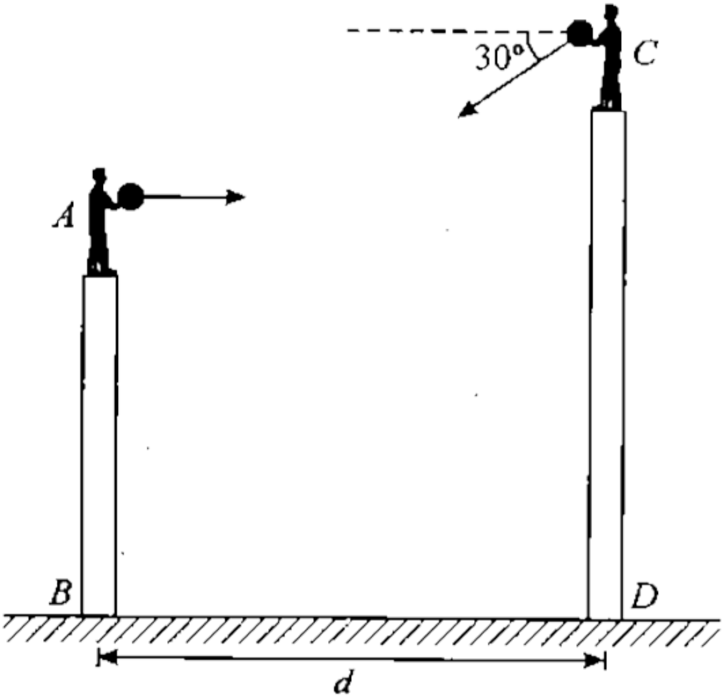
75. Two towers AB and CD are situated at a distance d apart, as shown in figure. AB is 20 m high and CD is 30 m high from the ground. An object of mass m is thrown from the top of AB horizontally with a velocity of 10 m/s towards

CD. Simultaneously another object of mass 2 m is thrown fromt the top of CD at an angle of 60° to the horizontal towards AB with the same magnitude of initial velocity as that oft he first object. The two objects move in the same vertical plane, collide in mid air and stick to each other (i) calculate the distance between the towers and (ii) find the position where the objects hit the ground.



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76. A particle moves uniformly with speed v along a parabolic path $y = kx^2$, where k is a positive constant. Find the acceleration of the particle at the point x = 0.

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77. A bullet of mass M is fired with a velocity $50m/s$ at an angle with the horizontal. At the highest point of its trajectory, it collides head-on with a bob of mass 3M suspended by a massless string of length $10/3$ metres and gets embeded in the bob. After the collision, the string moves through an angle of 120°.

Find

(i) the angle θ,

(ii) the vertical and horizontal coordinates of the initial position of the bob with respect to the point of firing of the bullet. Take $g = 10m / s^2$

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78. Two bodies are thrown simultaneously from the same point. One thrown straight up and the other at an angle α with the

horizontal. Both the bodies have velocity equal to u. Find the separation between the bodies at time t.

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79. A particle is moving in a plane with velocity $\vec{v} = u_0 \hat{i} + k\omega \cos \omega t \hat{j}$. If the particle is at origin at $t = 0$, (a) determine the trajectory of the particle. (b) Find its distance from the origin at $t = 3\pi / 2\omega$.

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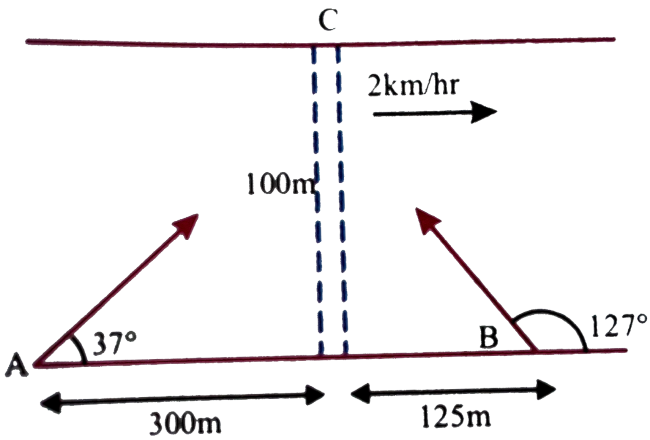
80. Two swimmers start a race. One who reaches the point C first on the other bank wins the race.A makes his strokes in a direction of 37^0 to the river flow with velocity $5km/hr$ relative to water. B makes his strokes in a direction 127^0 to the river flow with same relative velocity.River is flowing with speed of $2km/hr$ and is $100m$ wide.speeds of A and B on the ground are $8km/hr$ and

$6km / hr$ respectively.



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81. Two particles are simultaneously projected in the same vertical plane from the same point with velocities u and v at angles α and β with horizontal. Find the time that elapses when their velocities are parallel.

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82. Three points are located at the vertices of an equilateral triangle whose sides equal to $a = 3m$.They all start moving simultaneously with speed $v = 1m/s$, with the first point heading continually for the second, the second for the third, and the third for the first.How soon will the points meet?

83. A particle is projected up an inclined plane of inclination β at na elevation $\propto$ to the horizontal. Show that

(a) $\tan \propto = \cot \beta + 2 \tan \beta$, if the particle strikes the plane at right angles

(b) $\tan \propto = 2 \tan \beta$, if the particle strikes the plane horizontally.