PHYSICS

BOOKS - IE IRODOV PHYSICS (HINGLISH)

MECHANICS

Mechanics Problems

1. body with zero initial velocity moves down an inclined plane from a height hand then

ascends along the same plane with an initial velocity such that it stops at the ame height h. In which case is the time of motion longer?

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2. At a distance $L = 400m$ from the traffic light brakes are applied to a locomotive moving at a velocity $v = 54km / hr$. Determine the position of the locomotive relative to the traffic light 1 minute after the application of the brakes if its acceleration$is - 0.3m / s^2$.

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3. 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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4. A small ball thrown at an initial velocity v_0 at an angle α to the horizontal strikes elastically with a smooth vertical wall moving towards it at a horizontal velocity v and returns to the point from which it was thrown. Determine the time t from the beginning of motions to the moment of impact with vertical wall. Neglect friction losses.

5. A cannot fires from under a shelter inclined at an angle α to the horizontal (Fig.). The cannot is at point A at a (distance l from the base of the shelter (point B). The initial velocity of the shell is v_0, and its trajectory lies in the plane of the figure. Determine the maximum range $L_{\max}$ of the shell.

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6. The slopes of the windscreen of two motorcars are $\beta_1 = 30^\circ$ and $\beta_2 = 15^\circ$ respectively. At what ratio v_1 / v_2 of the velocities of the cars will their drivers see the hailstones bounced by the windscreen of their cars in the vertical direction ? Assume that haistones fall vertically.

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7. An aeroplane flying along the horizontal at a velocity v_0 starts to ascend, describing a circle in the vertical plane. The velocity of the plane changes with height h above the initial level of motion according to the law $v^2 = v_0^2 - 2a_0 h$. The velcity of the plane at the upper point of the trajectory is $v_1 = v_0/2$. Determine the acceleration a of the plane at the moment when its velocity is directed vertically upwards.

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8. An open merry-go-round rotates at an angular velocity ω. A person stands in it at a distance r from the rotational axis. It is raining, and the raindrops fall vertically at a velocity v_0. How should the person hold an umbrella to protect himself from the rain in teh best way ?

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9. A bobbin rolls without slipping over a horizontal surface so that the velocity v of the end of the thread (point A) is directed along the horizontal . A board hinged at point B leans against the bobbin (Fig.) The inner and outer radii of the bobbin are r and R respectively. Determine the angular velocity ω of teh board as a function of an angle α.

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10. A magnetic tape is wound on an emptyspool rotating at a constant angular velocity. The final radius r_t of the winding was found to be three times as large as the initial radius r_1 (Fig.). The winding time of the tape is t_1. What is the time t_2 required or winding a tape whose thickness is half that of the initial tape?

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11. If was found that the winding radius of a tape on a cassette was reduced by half in a time $t_1 = 20$ min of operation. In what time t_2 will the winding radius be reduced by half again ?

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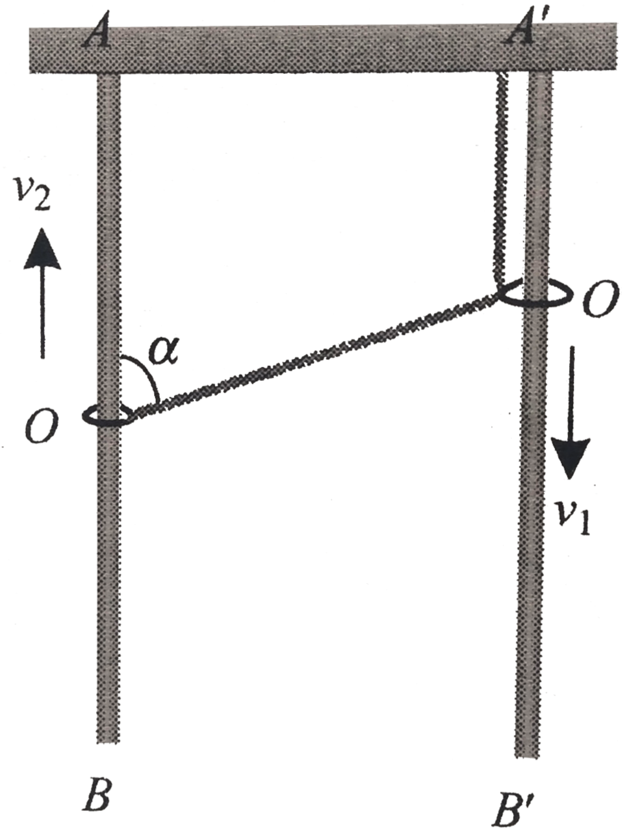
12. Two small rings O and O' are put on two vertical stationary rods AB and A'B', respectively. One end of an inextensible thread is tied at point A'. The thread passes through ring O' and its other end is tied to ring O. Assuming that ring O' moves downwards at a constant velocity v_1, then velocity v_2 of the ring O, when $\angle AOO' = \alpha$ is



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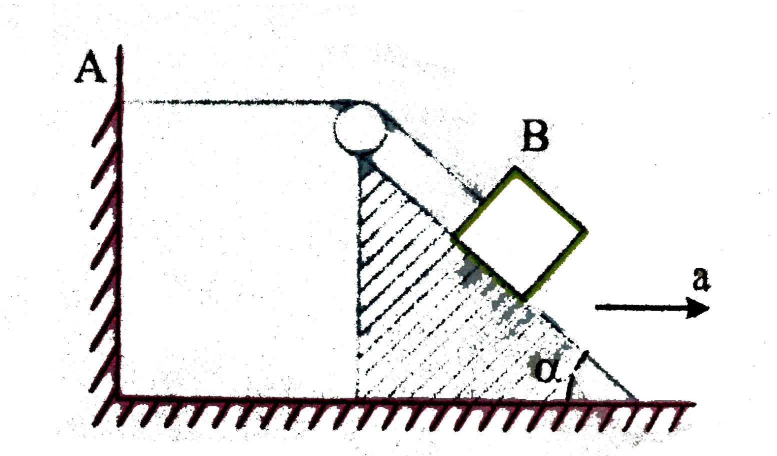
13. A weightless inextensible rope rests on a stationary wedge forming an angle α with a horizontal One end of the rope is fixed to the wall to point A.A small load is attached to the rope at point B The wedge starts moving to the right with a constant acceleration a The acceleration of the load is given by



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14. An ant runs from an ant-hill in a straight line so that its velocity is inversely proportional to the distance from the centre of the ant-hill. When the ant is at point A at a distance $l_1 = 1m$ from the centre of the ant-hill, its velocity $v_1 = 2cm/s$. What time will it take the ant to run from point A to point B which is at a distance $l_2 = 2m$ from the centre of the anthill ?

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15. During the motion of a locomotive in a circular path of radus R, wind is blowing in the horizontal direction. The trace left by the smoke is shown in Fig. (topview.) Using the figure, determine the velocity v_{wind} of the wind if it is known to be constant, and if the velocity v_{10c} of the loco-motive is $36km/h$.

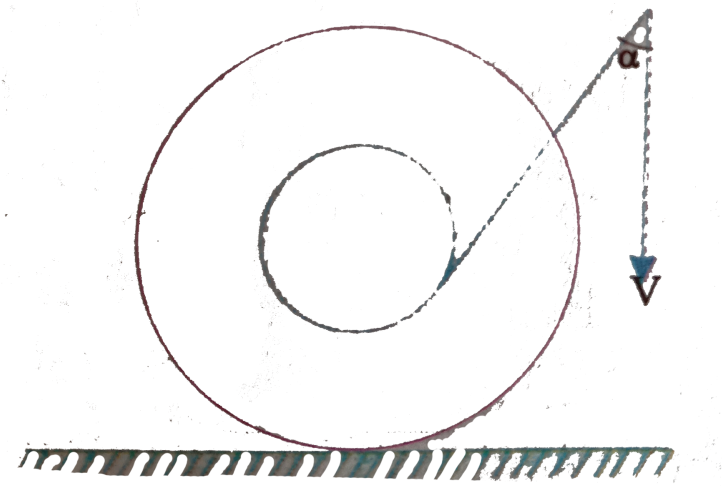
16. Three schoolboys, Sam, John, and Nick, are on merry-go-round. Sam and John occupy diametrically opposite points on a merry-go-round of radius r. Nick is on another merry-go-round of radius R. The positions of the boys at the initial instant are shown in Fig. Considering that the merry-go-round touch each other and rotate in the same direaction at the same angular velocity ω, determine the nature of motion of Nick from John's point of view and of Sam from Nick's point of view.

17. A hoop of radius R rests on a horizontal surface. A similar hoop moves past it at a velocity v. Determine the velocity v_A of the upper point of "intersection" of the hoops as a function of the distance d between their centres, assuming that the hoops are thin, and the second hoop is in contact with the first hoop as it moves past the latter.

18. A hinged construction consists of three rhombs with the ratio of sides 3 : 2 : 1

(Fig). Vertex A_3 moves in the horizontal direction at a velocity v. Determine the velocities of vertices A_1, A_2 and B_2 at the instant when the angles of the construction are 90°

19. The free end of a thread wound on a bobbin is passed round a nail A hammered into the wall. The thread is pulled at a constant velocity 'v' . Assuming pure rolling of bobin, find the velocity v_0 of the centre of the bobbin at the instant when the thread forms an angle α with the vertical: (R and r are outer and inner radii off the babbin)



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20. A rigid ingot is pressed between two parallel guides moving in horizontal directions at opposite velocities v_1 and v_2. At a certain instant of time, the points of contact between the ingot and the guides lie on a straight line perpendicular to the directions of velocities v_1 and v_2 (Fig). What points of teh ingot have velocities equal in magnitude to v_1 and v_2 at this instant ?

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21. A block lying on a long horizontal conveyer belt moving at a constant velocity receives a velocity $v_0 = 5m/s$ relative to the ground in the direction opposite to the direction of motion of the conveyer. After $t = 4s$, the velocity of the block becomes equal to the velocity of the belt. The coefficient of friction between the block and the belt is $\mu = 0.2$. Determine the velocity v of the conveyer belt.

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22. A body with zero initial velocity slips from the top of an inclined plane forming an angle α with the horizontal. The coefficient of friction μ between the body and the plane increases with the distance l from the top according to the law $\mu = bl$. The body stops before it reaches the end of the plane. Determine the time t from the beginning of motion of the body to the moment when it comes to rest.

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23. A rope is passed round a stationary horizontal log fixed at a certain height above

the ground. In order to keep a load of mass $m = 6$ kg suspended on one end of the rope, the maximum force $T_1 = 40N$ should be applied to the other end of the rope. Determine the minimum force T_2 which must be applied to the rope to lift the load.

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24. Why is it more difficult to turn the steering wheel of a stationary motorcar than of a moving car ?

25. A certain constant force starts acting on a body moving at a constant velocity v. After a time interval Δt, the velocity of the body is reduced by half, and after the same time interval, the velocity is again reduced by half. Determine the velocity v_f of the body after a time interval $3\Delta t$ from the moment when the constant force starts acting.

26. Two identical weightless rods are hinged to each other and to a horizontal beam (Fig.). The rigidity of each rod is k_0, and the angle between them is 2α. Determine the rigidity k of the system of rods relative to the vertical displacement of a hinge A under the action of a certain force F, assuming that displacements are small in comparison with the length of the rods.

27. Two heavy balls are simultaneously shot from two spring toy-guns arranged on a horizontal plane at a distance s = 10 m from each other. The first ball has the initial vertical velocity $v_1 = 10m/s$, while the second is shot at an angle α to the horizontal at a velocity $v_2 = 20m/s$. Each ball experiences the action of the force of gravity and the air drag $F = \mu v, \mu, = 0.1g/s$. Determine the angle cc at which the balls collide in air.

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28. A light spring of length l and rigidity k is placed vertically on a table. A small ball of mass m falls on it. Determine the height h from the surface of the tube at which the ball will have the maximum velocity.

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29. A heavy ball of mass m is tied to a weightless thread of length 1. The friction of the ball against air is proportional to its

velocity relative to the air: $F_{lr} = \mu v$. A strong horizontal wind is blowing at a constant velocity v. Determine the period T of small oscillations, assuming that the oscillations of the ball attenuate in a time much longer than the period of oscillations.

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30. A rubber string of mass m and rigidity k is suspended at one end. Determine the elongation Δl of the string.

31. For the system at rest shown in Fig., determine the accelerations of all the loads immediately after the lower thread keeping the system in equilibrium has been cut. Assume that the threads are weightless and inextensible, the springs are weightless, the mass of the pulley is negligibly small, and there is no friction at the point of suspension.

32. A person hoists one of two loads of equal mass at a constant velocity v (Fig). At the moment when the two loads are at the same height h, the upper pulley is released (is able to rotate without friction like the lower pulley). Indicate the load which touches the floor first after a certain time t, assuming that the person continues to slack the rope at the same constant velocity v. The masses of the pulleys and the ropes and the elongation of the ropes should be neglected.

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33. A block can slide along an inclined plane in various directions (Fig.). If it receives a certain initial velocity v directed downwards along the inclined plane, its motion will be uniformly decelerated, and it comes to rest after traversing a distance l_1. if the velocity of the same magntude is imparted to it in the upwards direction it comes to rest after traversing a distance l_2. At the botton of the inclined plane, a perfectly smooth horizontal guide is fixed. Determine the distance 1 traversed by the block over the inclined plane along the guide if the initial velocity of the same magnitude is imparted to it in the horizontal direction?

34. A block is pushed upwards along the roof forming an angle a with the horizontal. The time of the ascent of the block to the upper point was found to be half the time of its descent to the initial point. Determine the coefficient of friction lit between the block and the roof.

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35. Two balls are placed as shown in Fig. on a "weightless" support formed by two smooth inclined planes each of which forms an angle α with the horizontal. The support can slide without friction along a horizontal plane. The upper ball of mass m_1 i s released. Determine the condition under which the lower ball of mass m_2 tarts "climbing" up the support.

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36. A cylinder of mass m and radius r rests on two supports of the same height (Fig.). One support is stationary, while the other slides from under the cylinder at a velocity v. Determine the force of normal pressure N exerted by the cylinder on the stationary support at the moment when the distance between points A and B of the supports is $Ab = r\sqrt{2}$, assuming that the supports wery very close to each other at the initial instant. The friction between the cylinder and the supports should be neglected.

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37. cylinder and a wedge with a vertical face, touching each other, move along two smooth inclined planes forming the same angle α with the horizontal (Fig.). The masses of the cylinder and the wedge are m_1 and m_2 respectively. Determine the force of normal pressure N exerted by the wedge on the cylinder, neglecting the friction between them.

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38. A weightless rod of length l with a small load of mass m at the end is hinged at point A (Fig.) and occupies a strictly vertical position, touching a body of mass M. A light jerk sets the system in motion . For what mass ratio M/m will the rod form an angle $\alpha = \pi/6$ with the horizontal at the moment of the separation from the body ? What will be the velocity u of the body at this moment ? Friction should be neglected.

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39. A homogeneous rod AB of mass m and length l leans with its lower end against the wall and is kept in the inclined positions by a string DC (Fig). The string is tied at point C to the wall and at point D to the rod so that $AD = AB/3$. The angles formed by the string and the rod with the wall are α and β respectively. Find all possible values of the coefficient of friction μ between the rod and the wall.

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40. Two rigidly connected homogeneous rods of the same length and mass m_1 and m_2 respectively form an angle $\pi / 2$ and rest on a rough horizontal surface (Fig.) The system is uniformly pulled with the help of a string fixed to the vertex of the angle and parallel to the surface. Determine the angle α formed by the string and the rod of mass m_1.

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41. A ball moving at a velocity $v = 10m/s$ hits the foot of a football player. Determine the velocity u with which the foot should move for the ball impinging on it to come to a halt, assuming that the mass of the ball is much smaller than the mass of the foot and that the impact is perfectly elastic.

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42. A body of mass m freely falls to the ground. A heavy bullet of mass M shot along the horizontal hits the falling body and sticks in it. How will the time of fall of the body to the ground change? Determine the time t of fall if the bullet is known to hit the body at the moment it traverses half the distance, and the time of free fall from this height is to. Assume that the mass of the bullet is much larger than the mass of the body $(M > > m)$. The air drag should be neglected.

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43. Two bodies of mass $m_1 = 1kg$ and $m_2 = 2kg$ move towards each other in mutually perpendicular directions at velocities $v_1 = 3m/s$ and $v_2 = 2m/s$ (Fig). As a result of collision, the bodies stick together. Determine the amount of heat Q liberated as a

result of collisions.

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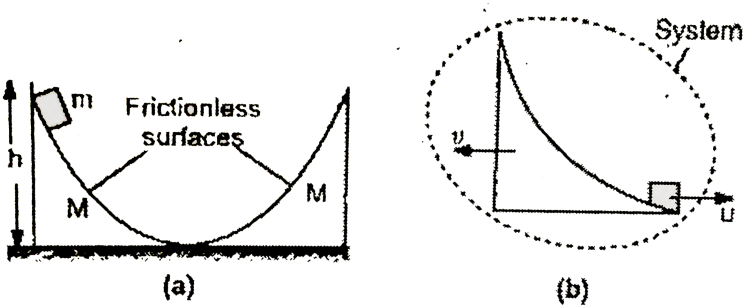
44. Two identical wedges of mass M are smoothly conjugated . The wedges are free to move on a smooth horizonal surface, A block of mass m is releaded from a height h on one of the wedge (See fig 4E.9)

(a) Show that the height h to which the mass m ascends the right wedge is

$$h_{\max} = \frac{M_2}{(M+m)^2}h.$$

(b) what mass ratio (M/m) results is

$$h_{\max} = h/4$$



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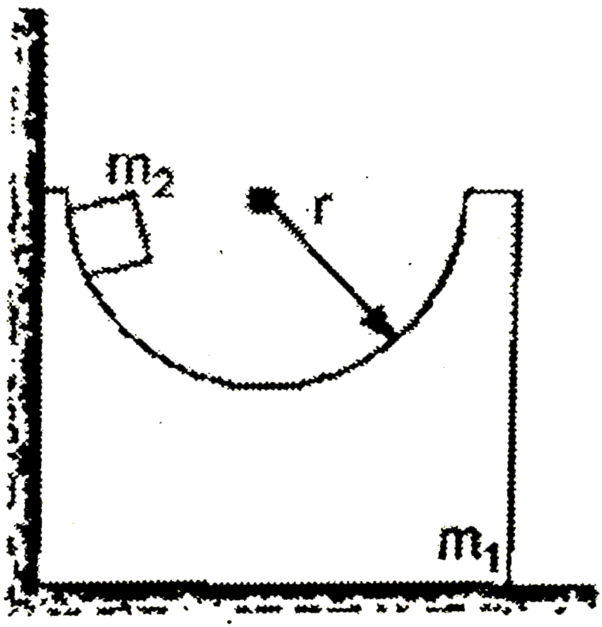
45. A wedge of mass m_1 with its upper surface hemispherical in shape, as shown in Fig. 4E.7(a), rests on a smooth horizontal surface near the wall. A small block of mass m_2 slides without friction on the hemispherical surface of the wedge. What is the maximum velocity attained by the wedge ?



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46. A round box of inner diameter D containing a washer of radius r lies on a table (Fig). The box is moved as a whole at a constant velocity v directed along the lines of centres of the box and the washer. At an instant t_0, the washer hits the box. Determine the time dependeces of the displacement x_{wash} of the waher and of its velocity v_{wash} relative to the table, starting from the instant t_0 and assuming that all the impacts of the washer against the box are perfectly elastic. Plot the graphs $x_{\text{wash}}(t)$ and $v_{\text{wash}}(t)$. The friction between the box and the washer should be neglected.

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47. A thin hoop of mass M and radius r is placed on a horizontal plane. At the initial instant, the hoop is at rest. A small washer of mass m with zero initial velocity slides from the upper point of the hoop along a smooth groove in the inner surfaces of the hoop. Determine the velocity u of the centre of the hoop at the moment when the washer is at a certain point A of the hoop, whose radius vector forms an angle ϕ with the vertical (figure). The friction between the hoop and the plane should be neglected

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48. A horizontal weightless rod of length 3l is suspended on two vertical strings. Two loads of mass m_1 and m_2 are in equilibrium at equal

distance from each other and from the ends of the strings (Fig). Determie the tension T of the left string at the instant when the right string snaps.

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49. A ring of mass m connecting freely two identical thin hoops of mass M each starts sliding down. The hoops move apart over a rough horizontal surface. Determine the acceleration a of the ring at the initial instant if $\angle AO_1O_2 = \alpha$ (Fig), neglecting the friction between the ring and the hoops.

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50. A flexible pipe of length l connects two points A and B in space with an altitude difference h (Fig). A rope passed through the pipe is fixed at point A. Determine the initial acceleration a of the rope at the instant when it is released, neglecting the friction between the rope and the pipe walls.

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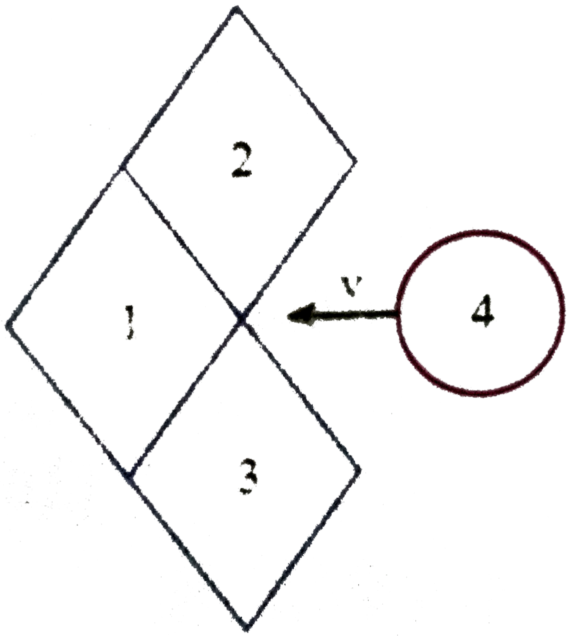
51. A smooth washer impinges at a velocity $'v'$ on a group of three smooth identical blocksresting on a smooth horizontal surface as shown in fig. Mass of each block is equal to mass of the washer. The diameter of the washer and its height are equal to edge of the block. The velocity of blocks (2) and (3) after collision is



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52. Several identical balls are at rest in a smooth stationary horizontal circular pipe. One of the balls explodes, distintegrating into two fragments of different masses. Determine the final velocity of the body formed as a result of all collisions, assuming that the collisions are perfectly inelastic.

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53. Three small bodies with the mass ratio 3 : 4: 5 (the mass of the lightest body is m) are kept at three different points on the inner surface of a smooth hemispherical cup of radius r. The cup is fixed at its lowest point on a horizontal surface. At a certain instant, the bodies are released. Determine the maximum amount of heat Q that can be liberated in such a system.At what initial arrangement of the bodies will the amount of liberated heat be maximum ? Assume that collisions are perfectly inelastic.

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54. Why is it recommended that tha air pressure in motorcar tyres be reduced for a motion of the motorcar over sand ?

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55. A long smooth cylindrical pipe of radius r is tilted at an angle α to the horizotal (Fig). A small body at point A is pushed upwards along the inner surface of the pipe so that the direction of its initial velocity forms an angle φ with generatrix AB. Determine the minimum initial velocity v_0 at which the body starts moving upwards without being separated from the surface of the pipe.

56. An inextensible rope tied to the axle of a wheel of mass m and radius r is pulled in the horizontal direction in the plane of the wheel. The wheel rolls without jumping over a grid consisting of parallel horizontal rods arranged at a distance 1 from one another $(1 < r)$. Determine the average tension T of the rope at which the wheel moves at a constant velocity v, assuming the mass of the wheel to be concentrated at its axle.

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57. A thin rim of mass m and radius r rolls down an inclined plane of slope α, winding thereby a thin ribbon of linear denstiy ρ (Fig). At the initial moment, the rim is at a height h above the horizontal surface. Determine the distance s from the foot of the inclined plane at which the rim stops, assuming that the inclined plane smoothly changes into the horizontal plane.

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58. Two small balls of the same size and of mass m_1 and $m_2(m_1 > m_2)$ are tied by a thin weightless thread and dropped from a ballon. Determine the tension T of the thread during the flight after the motion of the balls has become steady-state.

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59. A ball is tied by a weightless inextensible thread to a fixed cylinder of radius r. At the initial moment the thread is wound so that the ball touches the cylinder. Then the ball acquires a velocity v in the raidal direction, and the thread starts unwinding (Fig). Determine the length l of the upwound segment of the thread by the instant of time t, neglecting the force of gravity.

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60. Three small balls of the same mass, white (w), green (g), and blue (b), are fixed by weightless rods at the vertics of the equilateral triangle with side l. The system of balls is placed on a smooth horizontal surface and set in rotation about the centre of mass with period T. At a certain instant, the blue ball tears away from the frame. Determine teh distance L between the blue and the green ball after the time T.

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61. A block is connected to an identical block through a weightless pulley by a weightless inextensible thread of length 2l (Fig). The left block rests on a table at a distance l from its edge, while the right block is kept at the same level so that the thread is unstretched and does not sag, and then released. What will happen first will the left block reach the edge of the table (and touch the pulley) or the right block hit and table?

62. Two loads of the same mass are tied to the ends of a weightless inextensible thread passed through a weightless pulley (Fig.). Initially, the system is at rest,and the loads are at the same level. Then the right load abruptly acquires a horizontal velocity v in the plane of the figure. Which load will be lower in a time?

63. Two balls of mass $m_1 = 56g$ and $m_2 = 28g$ are suspended on two threads of length $l_1 = 7cm$ and $l_2 = 11cm$ at the end of a freely hanging rod (Fig). Determine the angular velocity o at which the rod should be rotated about the vertical axle so that it remains in the vertical position.

64. A weightless horizontal rigid rod along which two balls of the same mass m can move without friction rotates at a constant angular velocity ω about a vertical axle. The balls are connected by a weightless spring of rigidity k, whose length in the undeformed state is l_0. The ball which is closer to the vertical axle is connected to it by he same spring. Determine the lengths of the springs. Under what conditions will be balls move in circles ?

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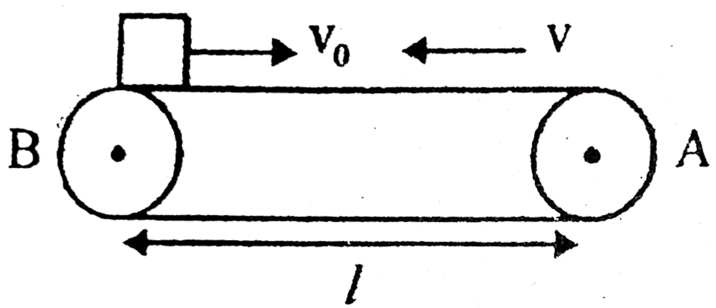
65. A conveyed belt of length lis moving with velocity v.a block of mass is pushed against the motion of conveyed belt with velocity v_0 form end B Co- efficient of friction between block and belt is u the value of v_0 so that the amount of heat liberated as a result of retardation of the block by conveyed belt is maximum is



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66. A heavy pipe rolls from the same height down two hills with different profiles (Figs.) In the former case, the pipe rolls down without slipping, while in the latter case, it slips on a certain region. In what case will the velocity of the pipe at the end of the path be lower ?

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67. A heavy load is suspended on a light spring. The spring is slowly pulled down at the midpoint (a certain work A is done thereby) and then released. Determine the maximum kinetic energy W_k of the load in the subsequent motion.

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68. The masses of two stars are m_1 and m_2, and their separation is l. Determine the period

T of their revolution in circular orbits about a common centre.

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69. A meteorite approaching a planet of mass M (in the straight line passing through the centre of the planet) collides with an automatic space station orbiting the planet in a circular trajectory of radius R. The mass of the station is ten times as large as the mass of the meteorite. As a result of the collision, the meteorite sticks in the station which goes over to a new orbit with the minimum distance R/2 from the planet. Speed of the meteorite just before it collides with the planet is : .

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70. The cosmonauts who landed at the pole of a planet found that the force of gravity there is 0.01 of that on the Earth, while the duration of the day on'the planet is the same as that on the Earth. It turned out besides that the force of gravity on the equator is zero. Determine the radius R of the planet.

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71. Calculate the period of revolution of Neptune around the sun, given that diameter of its orbit is 30 times the diameter of earth's orbit around the sun, both orbits being assumed to be circular.

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72. Three loads of mass m_1, m_2 and M are suspended on a string passed through two pulleys as shown in Fig. The pulleys are at the same distance from the points of suspension. Find the ratio of masses of the loads at which the system is in equilibrium. Can these conditions always be realized? The friction should be neglected.

73. Determine the minimum coefficient of friction $\mu_{\min}$ between a thin homogeneous rod and a floor at which a person can slowly lift the rod from the floor without slippage to the vertical position, applying to its end a force perpendicualr to it.

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74. Three weightless rods of length 1 each are hinged at points A and B lying on the same horizontal and joint through hinges at points C and D (Fig.). The length $AB = 2l$. A load of mass m is suspended at the hinge C. Determine the minimum force $F_{\min}$ aplied to the hinge D for which the middle rod remains horizontal.

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75. A homogeneous rod of length 2l leans against a vertical wall at one end and against a smooth stationary surface at another end. What function y (.x) must be used to describe the cross section of this surface for the rod to remain in equilibrium in any position even in the absence of friction? Assume that the rod remains all the time in the same vertical plane perpendicular to the plane of the wall.

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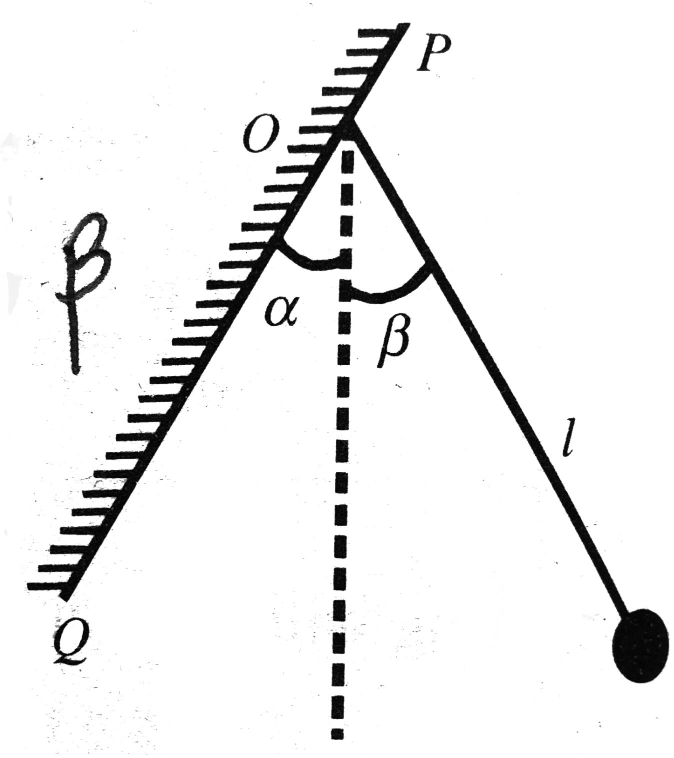
76. A ball is suspended by a thread of length l at the point O on an incline wall as shown. The inclination of the wall with the vertical is α.The thread is displaced through a small angle β away from the vertical and the ball is released. Find the period of oscillation of pendulum.



Consider both cases

a. $\alpha > \beta$

b. $\alpha < \beta$

Assuming that any impact between the wall and the ball is elastic.

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77. A ball of mass m falls from a certain height on the pan of mass $M(M > > m)$ of a spring balance. The rigidity of the s prin is k. Determine the displacement Δx of the point about which the pointer of the balance will oscillate, assuming that the collisions of the ball with the pan are erfectly elastic.

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78. A bead of mass m can move without friction along a long wire bent in a vertical plane in the shape of a graph of a certain function. Let l_A be the length of the segment of the wire from the origin to a certain point A. It is knonw that if the bead is released at point A such that $l_A < l_{A_0}$, its motion will be strictly harmonic $l(t) = l_A \cos \omega t$. Prove that there exists a point $B(l_{A_0} < < l_B)$ at which the condition of harmonicity of oscillations will be violated.

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79. Two blocks having mass m and 2m and connected by a spring of rigidity k lie on a horizontal plane. Determine the period T of small longitudinal oscillations of the ystem, neglecting friction.

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80. A heavy round log is suspended at the ends on two ropes so that the distance between the points of suspension of the ropes is equal to the diameter of the log. The length of each vertical segment of the ropes is 1. Determine the period T of small oscillations of the system in a vertical plane perpendicular to the log.

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81. A load of mass M is on horizontal rails. A pendulum made of a ball of mass m tied to a weightless inextensible thread is suspended to the load. The load can move only along the rails. Determine the ratio of the periods T_2 / T_1 of small oscillations of the pendulum in vertical planes parallel and perpendicular to the rails.

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82. Four weightless rods of length l each are connected by hinged joints and form a rhomb (Fig). A hinge A is fixed, and a load is suspended to a hinge C. Hinges D and B are connected by a weightless spring of length $1.5l$ in the undeformed state. In equilibrium, the rods form angles $\alpha_0 = 30^\circ$ with the vertical. Determine the period T of small oscillations of the load.

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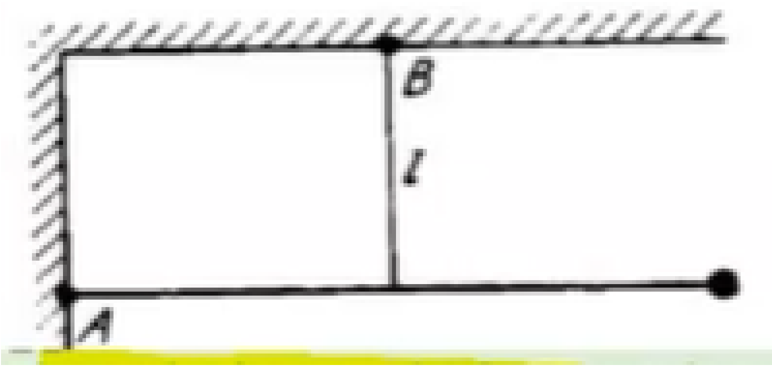
83. A weightless rigid rod with a load at the end is hinged at point A to the wall so that it can rotate in all directions (Fig).



The rod is kept in the horizontal position by a vertical inextensible thread of length 1, fixed at its midpoint. The load receives a momentum in the direction perpendicular to the plane of the figure.

Determine the period T of small oscillations of the system.

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84. One rope of a swing is fixed above the other rope by b. The distance between the poles of the swing is a. The lengths l_1 and l_2 of the ropes are such that $l_1^2 + l_2^2 = a^2 + b^2$ (Fig).

Determine the period T of small oscillations of the swing, neglecting the height of the swinging person in comparison with the above lengths.

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85. Being a punctual man, the lift operator of a skyscraper hung an exact pendulum clock on the lift wall to know the end of the working day. The lift moves with an upward and downward accelerations during the same time (according to a stationary clock), the magnitudes of the accelerations remaining unchanged.

Will the operator finish his working day in time, or will he work more (less) than required?

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86. An aluminium wire is wound on a piece of cork of mass m_{cork}. The densities ρ_{cork}, ρ_{a1}, and ρ_w, of cork, aluminium, and water are $0.5 \times 10^3 kg/m^3$, $2.7 \times 10^3 kg/m^3$, and

$1 \times 10^3 kg/ms$ respectively. Determine the minimum mass ma t of the wire that should be wound on the cork so that the cork with the wire is completely submerge 1 in water.

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87. One end of an iron chain is fixed to a sphere of mass M = 10 kg and of diameter D = 0.3 m (the volume of such a sphere is $V = 0.0141 m^3$), while the other end is free. The length 1 of the chain is 3 m and its mass m is 9 kg. The sphere with the chain is in a reservoir whose depth $H = 3m$.

Determine the depth at which the sphere will float, assuming that iron is 7.85 times heavier than water.

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88. Two bodies of the same volume but of different masses are in equilibrium on a lever. Will the equilibrium be violated if the lever is immersed in water so that the bodies are completely submerged?

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89. A flat wide and a high narrow box float in two identical vessels filled with water. The boxes do not sink when two identical heavy bodies of mass m each are placed into them. In which vessel will the level of water be higher?

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90. A steel ball floats in a vessel with mercury. How will the volume of the part of the ball submerged in mercury change if a layer of water completely covering the ball is poured above the mercury?

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91. A piece of ice floats in a vessel with water above which a layer of a lighter oil is poured. How will the level of the interface change after the whole of ice melts? What will be the change in the total level of liquid in the vessel?

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92. A jet plane having a cabin of length = 50 m flies along the horizontal with an acceleration $a = 1m/s^2$. The air density in the cabin is $\rho = 1.2 \times 10^{-3} g/cm^3$.

What is the difference between the atmospheric pressure and the air pressure exerted on the ears of the passengers sitting in the front, middle, and rear parts of the cabin?