PHYSICS

NCERT - NCERT PHYSICS(ENGLISH)

LAWS OF MOTION

Solved Example

1. An astronaut accidentally gets separated out his small spaceship accelerating in interstellar space at a constant rate of

$100ms^{-2}$. What is the acceleration of the astronaut the instant after he is outside the spaceship? (Assume that there are no nearby stars to exert gravitional force on him)

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2. A bullet of mass 0.04 kg moving with a speed of $90ms^{-1}$ enters a heavy wooden block and is stooped after a distance of 60 cm . What is the average resistive force exerted by the block on the bullet ?

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3. The motion of a particle of mass m is described by $y = ut + \frac{1}{2}gt^2$. Find the force acting on the particale .

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4. A batsman hits back a ball straight in the direction of the bowler without changing its initial speed of $12ms^{-1}$. If the mass of the ball is 0.15 kg , determine the impulse

imparted to the ball . (Assume linear motion of the ball).

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5. Two identical billiard balls striks a rigid wall with the same speed but at different angles , and get reflected without any change in speed , as shown in Fig . What is (i) the direction of the force on the wall due to each ball ? (ii) the ratio of the magnitudes of impulses imparted to the balls by the wall ?

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6. A mass of 6 kg is suspended by a rope of length 2 m from the ceilling A force of 50 N in the horizontal direction is applied at the mid - point P of the rope as shown . What is the angle the rope makes with the vertical in equilibrium ? (Take = $10ms^{-2}$) . Neglect mass of the rope .

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7. Detrmine the maximum acceleration of the train in which a box lying on the floor will remain stationary given that the coefficient of static friction between the box and the train s floor is 0.15 given $g = 10m/s^2$.

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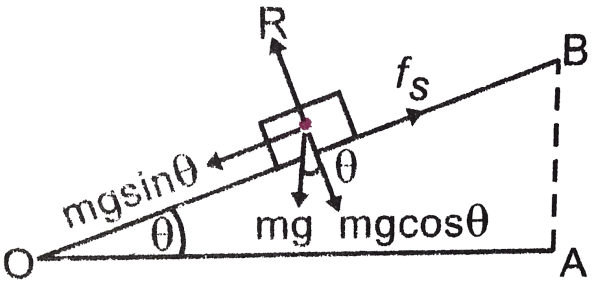
8. A mass of 4 kg rest on a horizontal plane . The plane is gradually inclined until an angle $0 = 15^\circ$ with the horizontal and the mass just

begins to slide . What is the coefficient of static friction between the block and the surface ?



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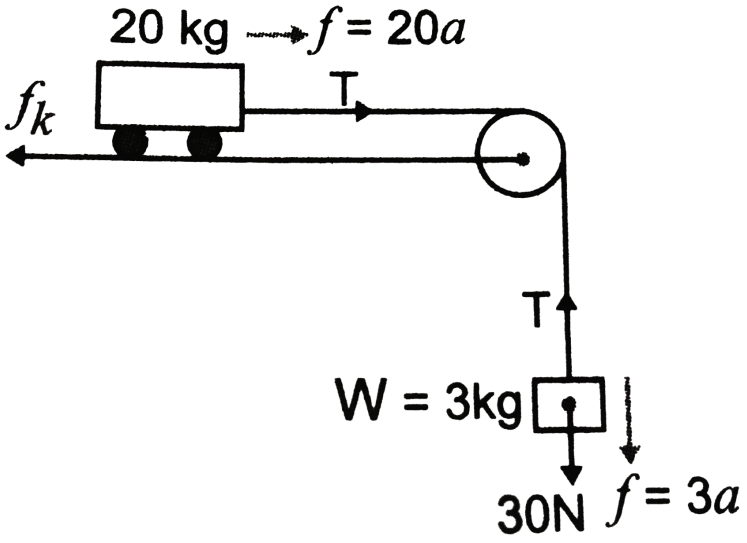
9. What is the acceleration of the block and trolley system shown in if the coefficient of

kinetic friction between the trolley and the surface is 0 .04 ? What is the tension in the string ? Take $g = 10ms^{-2}$ Neglect the mass of the string



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10. A cyclist speeding at $18km/h$ on a level road takes a sharp circular turn of radius 3 m without reducing the speed . The coefficient of static friction between the tyres and the road is 0.1 Will the cyclist slip while taking the turn ?

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11. A circular racetrack of radius 300 m is banked at an angle of 15° If the coefficient of friction between the wheels of a race car and

the road is 0.2 what is the (a) optimum speed of the race car to avoid wear and tear on its tyres , and (b) maximum permissible speed to aviod slipping ?

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12. A wooden block of mass 2 kg rests on a soft horizontal floor . When aniron cylinder of mass 25 kg is placed on top of the block , the floor yields steadily , and the block and the cylinder go down with an acceleration of $0.1ms^{-2}$

What is the action of the block on the floor (a) before and (b) after the floor yields ? Take $g = 10ms^{-2}$. Identify the action reaction pairs in the problem .

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Exercise

1. Give the magnitude and direction of the net force acting on

(a) a drop of rain falling down with a constant

speed

(b) a cork of mass 10 g floating on water

(c) a kite skillfully held stationary in the sky

(d) a car moving with a constant velocity of $30kh/h$ on a rough road

(e) a high speed electron in space free from all gravitational objects and free of electric and magnetic fields.

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2. A pebble of mass 0.05 kg is thrown vertically upwards Give the magnitude and direction of net force on the pebble (a) during its upward motion (b) during its downward motion (c) at the highest point where it is momentarily rest Do your answers change if the pebble were thrown at an angle of say 45° horizontal direction.

Ignore air resistance.

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3. Give the magnitude and direction of the force acting on a stone of mass 0.1 kg (a) just after it is dropped from the window of a stationary train

(b) just after it is dropped from the window of a train running at a constant velocity of $36km/hr$

(c) just after it is dropped from the window of a train accelerating with $1ms^{-2}$

(d) lying on the floor of a train which is accelerating with $1ms^{-2}$ the stone being at rest relative to the train .

Neglect the resistance of air throughout .

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4. One end of string of length l is connected to a particle on mass m and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed v the net force on the particle (directed toward centre) will be (T reprents the tension in the string):

A. T

B. T - mv^2/l

C. T + mv^2 / l

D. 0

Answer:

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5. A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of $15ms^{-1}$ How long does the body take to stop ?

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6. A constant force acting on a body of mass $3kg$ changes its speed from $2ms^{-1}$ to $3.5ms^{-1}$ in 25 s. The direction of motion of the body remains unchanged. Calculate magnitude and direction of the force.

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7. A body of mass 5 kg is acted upon by two perpendicular forces 8 N and 6 N Give the

magnitude and direction of the acceleration of the body.

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8. The driver of a three wheeler moving with a speed of $36 km / h$ sees a child standing in the middle of the road and brings his vehicle to rest in 4 s just in time to save the child What is the average retarding force on the vehicle ? The mass of three wheeler is 400 kg and mass of the driver is 65 kg.

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9. A rocket with a lift off mass 20000 kg is blasted upwards with a net initial acceleration of $5ms^{-2}$ Calculate the initial thrust (force) of the blast.

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10. A body of mass 0.40 kg moving initially with a constant speed of $10m/s$ to the north is subjected to a constant force of 8.0 N

directed towards the south for 30 s Take the instant the force is applied to be t = 0, and the position of the particle at that time to be x = 0, predict its position at $t = -5s, 25s, 100s$?

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11. A truck starts from rest and accelerate uniformly with $2ms^{-2}$. At t = 10 s a stone is dropped by a person standing on the top of the truck (6 m high from ground). What are

the (a) velocity and (b) acceleration of the stone at t = 11 s ? Neglect air resistance.

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12. A bob of mass 0.1 kg hung from the ceiling of a room by a string 2 m long is set into oscillation The speed of the bob at its mean position $1m/s$ What is the trajectory of the bob if the string is cut when the bob is (a) at one of its extreme position (b) at is mean position ?

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13. A man of mass 70 kg stands on a weighing machine in a lift, which is moving (a) upwards with a uniform speed of $10ms^{-1}$

(b) downwards with a uniform acceleration of $5ms^{-2}$

(c) upwards with a uniform acceleration of $5ms^{-2}$ What would be the readings on the scale in each case ?

(d) What would be the reading if the lift

mechanism failed and it hurtled down freely under gravity ?

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14. Fig. shows the position-time graph of a particle of mass 4 kg. What is the (i) force acting on the particle for $t < 0, t < 4s, 0 < t < 4s$? (ii) impulse at t = 0 and t = 4 s? Assume that the motion is one

dimensional.

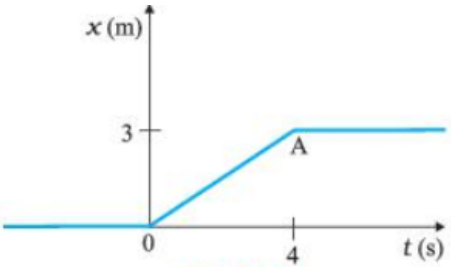

Fig.

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15. Two bodies of masses 10 kg and 20 kg respectively kept on a smooth horizontal surface are tied to the ends of a light string A horizontal force F = 600 N is applied to (i) A

and (ii) B along the direction of string. What is the tension in the string in each case ?

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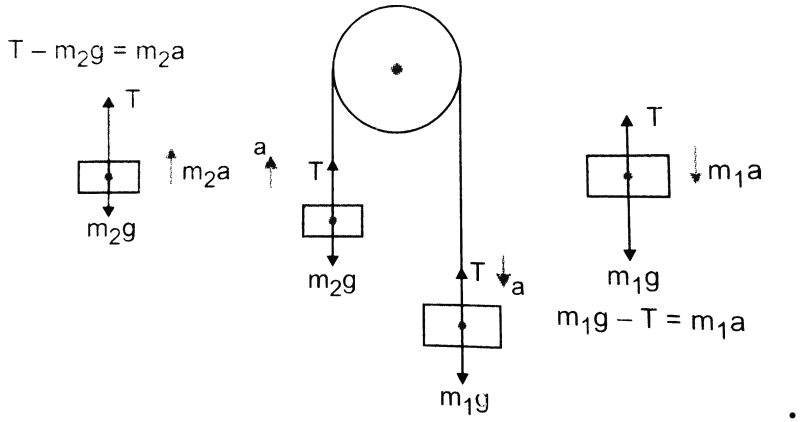
16. Two masses 8 kg and 12 kg are connected at the two ends of a light in extensible string that passes over a friction less pulley. Find the acceleration of the masses and tension in the

string , when the masses are released



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17. A nucleus is at rest in the laboratory frame of reference. Show that if it disintegrates into two smaller nuclei the products must be emitted in opposite directions.

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18. Two billiard balls each of mass 0.05 kg moving in opposite directions with speed $6ms^{-1}$ collide and rebound with the same speed. What is the impulse imparted to each ball due to the other ?

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19. A shell of mass 200g is fired by a gun of mass 100kg. If the muzzle speed of the shell is

$80ms^{-1}$, then the recoil speed of the gun is

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20. A batsman deflects a ball by an angle of 45° without changing its initial speed which is equal to $54k\frac{m}{h}$. What is the impulse imparted to the ball ? (Mass of the ball is 0.15 kg)

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21. A stone of of mass 0.25 kg tied to the end of a string is whirled round in a circle of radius 1.5 m with a speed of $40 rev / \min$ in a horizontal plane What is the tension in the string ? What is the maximum speed with which the stone can be whirled around If the string can withstand a maximum tension of 200 N ?

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22. If in Q . 21 the speed of the stone is increased beyond the maximum permissible value and the string breaks suddenly which of the following correctly describes the trajectory of the stone after the string breaks :

(a) the stone jerks radially outwards

(b) the stone flies off tangentially from the instant the string breaks

(c) the stone flies off at an angle with the tangent whose magnitude depends on the speed of the stone ?

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23. Explain why

(a) A horse cannot pull a cart and run in empty space.

(b) Passengers are thrown forward from their seats when a speeding bus stops suddenly.

(c) A cricketer moves his hands backwards when holding a catch.

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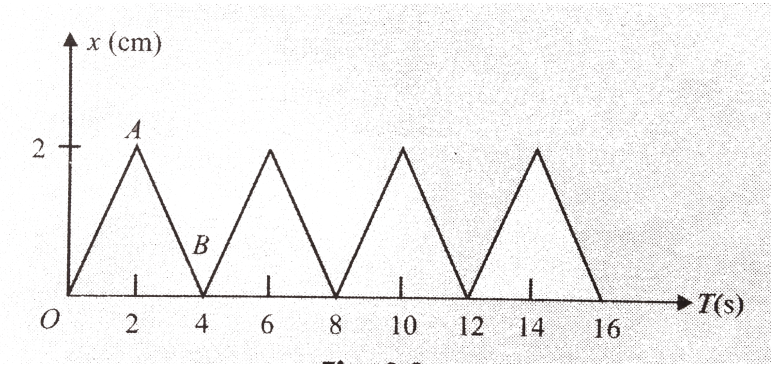
24. Figure shows the position-time graph of a particle of mass $0.04kg$. Suggest a suitable physical context for this motion. What is the time between two consecutive impulses received by the particle? What is the magnitude of each impulse?



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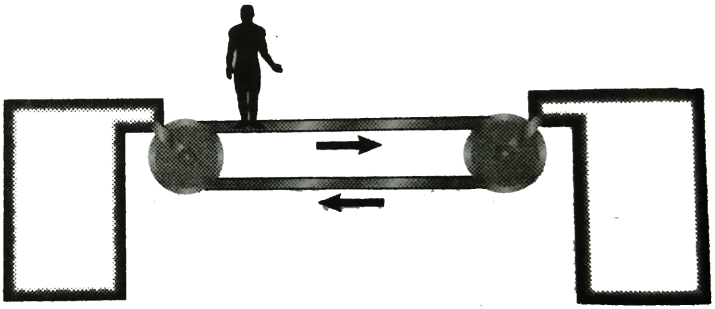
25. Figure shown a man standing stationary with respect to a horizontal converyor belt that is accelerationg with $1m/s^{-2}$. What is the net force on the man?If the coefficient of ststic friction between the man's shoes and the belt is 0.2 upto what maximum acceleration of the belt can the man continue to be stationary relative to the belt? Mass of

the man $= 65kg\left(g = 9.8m/s^2\right)$



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26. A stone of mass m tied to the end of a string revolves in a vertical circle of radius R. The net forces at the lowest and highest points of the circle directed vertically

downwards are: [Choose the correct alternative]

	Lowest Point	Highest Point
(a)	$mg - T_1$	$mg + T_2$
(b)	$mg + T_1$	$mg - T_2$
(c)	$mg + T_1 - (mv_1^2) / R$	$mg - T_2 + (mv_1^2) / R$
(d)	$mg - T_1 - (mv_1^2) / R$	$mg + T_2 + (mv_1^2) / R$

T_1 and V_1 denote the tension and speed at the lowest point T_2 and V_2 denote the corresponding values at the highest points.

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27. A helicopter of mass 1000 kg rises with a vertical acceleration of $15ms^{-2}$. The crew and the passengers weigh 300 kg. Give the

magnitude and direction of the

(a) force on the floor by the crew and passengers,

(b) action of the rotor of the helicopter on the surroundings air,

(c) force on the helicopter due to the surroundings air.

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28. A stream of water flowing horizontally with a speed of $15ms^{-1}$ pushes out of a tube of

cross sectional area $10^{-2}m^2$ and hits a vertical wall near by what is the force exerted on the wall by the impact of water assuming.that it does not rebound? (Density of water $= 1000kgm^3$)

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29. Ten one-rupee coins are put on top of each other on a table. Each coin has a mass m . Give the magnitude and direction of

(a) the force on the 7^{th} coin (counted from the

bottom due to all the coins on its top.

(b) the force on the 7^{th} coin by the eight coin.

(c) the reaction of the 6^{th} coin one the 7^{th} coin.

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30. An aircraft executes a horizontal loop at a speed of $720 kmh^{-1}$, with its wings banked at 15° What is the radius of the loop ?

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31. A train rounds an unbanked circular bend of radius 30 m at a speed of $54 km/h$. The mass of the train is 10^6 kg. What provides the centripetal force required for this purpose - The engine or the rails ? What is the angle of banking required to prevent wearing out the rails ?

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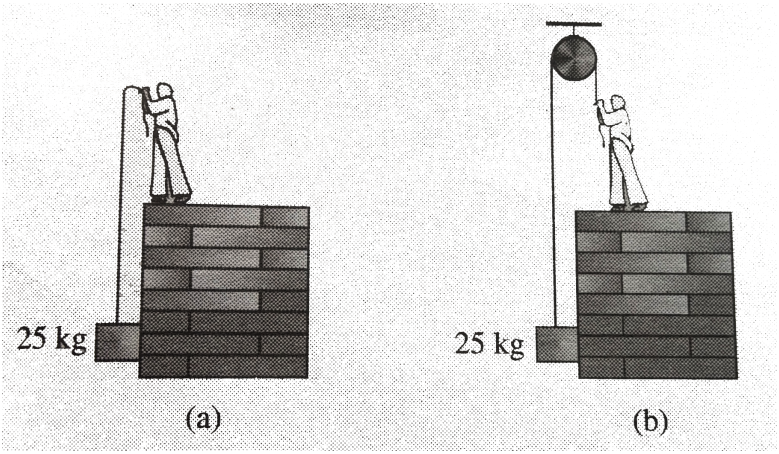
32. A block of mass 25 kg is raised by a 50kg man in two different ways as shown in fig.

what is the action on the floor by the man in the two cases? If the floor yields to a normal force of $700N$, which mode should the man adopt to lift the block without the floor yielding?



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33. A monkey of mass 40 kg climbs on a rope which can withstand a maximum tension of 600 N In which of the following cases will the rope break : The monkey

(a) climbs up with an acceleration of $6ms^{-2}$

(b) climbs down with an acceleration of $4ms^{-2}$

(c) climbs up with a uniform speed of $5ms^{-1}$

(d) falls down the rope nearly freely under gravity ? (Ignore the mass of the rope.)

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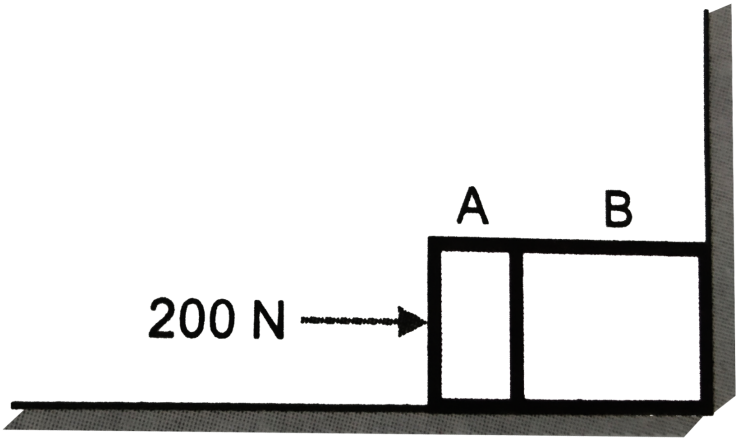
34. Two bodies A and B of mass 5 kg and 10 kg contact with each other rest on a table against a rigid The coefficient of friction between the bodies and the table is 0.15 A force of 200 N is applied horizontal on A What are (a) the reaction of thee wall (b) the the action , reaction forces between A & B ? What happens when the wall is removed ? Does the answer to (b) Change, when the bodies are in

motion ? Ignore difference between μ_s and μ_k



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35. A block of mass 15 kg is placed on a long trolley . The coefficient of friction between the block and trolley is 0.18 The trolley accelerates from rest at $0.5m/s^2$ for 20 seconds and then

moves with a uniform velocity Discuss the motion of the block as viewed by (i) a stationary observer on the ground, (ii) an observer moving with the trolley.

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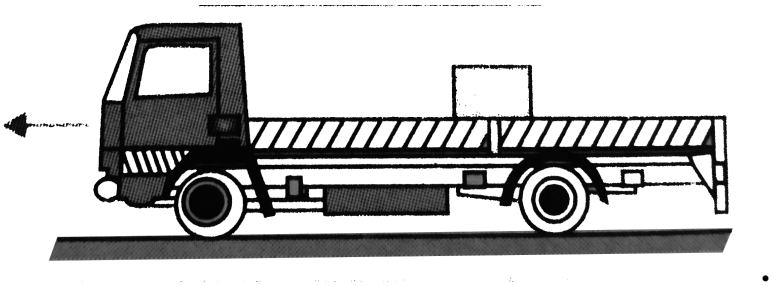
36. The rear side of a truck is open and a box of 40 kg mass is placed 5 m from the openend as shown The coefficient of friction between the box and the surface below it is 0.15 On a straight road the truck starts from rest and

accelerates with $2ms^{-2}$ At what distance from the starting point does the box fall off the truck ? (Ignore the size of the box)



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37. A long plying record revolves with a speed of $33\frac{1}{3}\text{rev min}^{-1}$, and has a radius of 15 cm. Two coins are placed at 4 cm and 14 cm away from the centre of the record. If the coefficient

of friction between the coins and the record is 0.15, which of the two coins will revolve with the record ? Take $g = 9.8ms^{-2}$.

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38. You may have seen in a circus a motorcyclist driving in vertical loops inside a death well (a hollow spherical chamber with holes, so the spectators can watch from outside). Explain clearly why the motorcyclist does not drop down when he is at the

uppermost point of death well with no support from below. What is the minimum speed required at the uppermost position to perform a vertical loop if the radius of the chamber is 25 m ?

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39. A $70kg$ man stands in contact against the inner wall of a hollow cylindrical drum of radius $3m$ rotating about its vertical axis. The coefficient of friction between the wall and his

clothing is 0.15. What is the minimum rotational speed of the cylinder to enable the man to remain stuck to the wall (without falling) when the floor is suddenly removed?

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40. A thin circular wire of radius R rotates about its vertical diameter with an angular frequency ω. Show that a small bead on the wire remain at its lowermost point for $\omega \leq \sqrt{g/R}$. What is angle made by the

radius vector joining the center to the bead with the vertical downward direction for $\omega = \sqrt{2g/R}$? Neglect friction.

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