KD EDUCATION ACADEMY [9582701166]

Time : 6 Hour | **Physics** | **Total Marks : 450**

kd 90+ ch-4 laws of motion

*** Choose The Right Answer From The Given Options.[1 Marks Each]** **[32]**

1. A cricket ball of mass 150g has an initial velocity $\mathrm{u} = (3\hat{\mathrm{i}} + 4\hat{\mathrm{j}})\mathrm{m\ s^{-1}}$ and a final velocity $\mathrm{v} = -(3\hat{\mathrm{i}} + 4\hat{\mathrm{j}})\mathrm{m\ s^{-1}}$ after being hit. The change in momentum (final momentum-initial momentum) is (in kg m s^1):

   (A) zero

   (B) $-(0.45\hat{\mathrm{i}} + 0.6\hat{\mathrm{j}})$

   (C) $-(0.9\hat{\mathrm{i}} + 1.2\hat{\mathrm{j}})$

   (D) $-5(\hat{\mathrm{i}} + \hat{\mathrm{j}})$

2. A bomb at rest explodes into 3 parts of the same mass. The momentum of 2 parts are $-2\hat{\mathrm{i}}$ and $\mathrm{p}\hat{\mathrm{j}}$. The momentum of the third part will have a magnitude of,

   (A) p (B) $\sqrt{3}\mathrm{p}$ (C) $\sqrt{3\mathrm{p}}$ (D) zero

3. A particle of mass m moving with a velocity v strikes a stationary particle of mass 2m and stickes to it. The speed of the system will be,

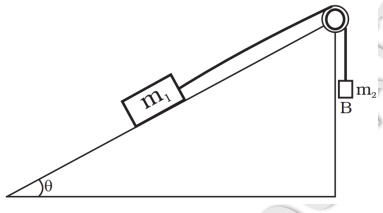
   (A) $\frac{\mathrm{v}}{2}$

   (B) $2\mathrm{v}$

   (C) $\frac{\mathrm{v}}{3}$

   (D) $3\mathrm{v}$

4. Mass m_1 moves on a slope making an angle θ with the horizontal and is attached to mass m_2 by a string passing over a frictionless pulley as shown in The co-efficient of friction between m_1 and the sloping surface is μ. Which of the following statements are true?



   (A) If $m_2 > m_1 \sin\theta$, the body will move up the plane.

   (B) If $m_2 > m_1 (\sin\theta + \mu\cos\theta)$, the body will move up the plane.

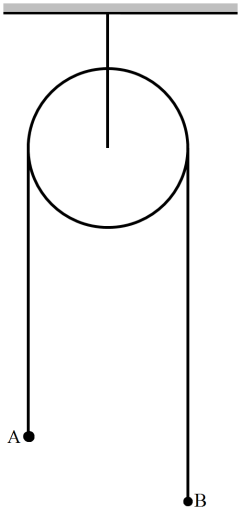
   (C) If $m_2 < m_1 (\sin\theta + \mu\cos\theta)$, the body will move up the plane.

   (D) If $m_2 < m_1 (\sin\theta - \mu\cos\theta)$, the body will move down the plane.

5. A body of mass 2kg travels according to the law $x(t) = pt + qt^2\ rt^3$ where p = 3m s^{-1}, q = 4m s^{-2} and r = 5m s^{-3}. The force acting on the body at t = 2 seconds is.

   (A) 136N (B) 134N (C) 158N (D) 68N

6. The pulley in the diagram is smooth and light. The masses of A and B are 5kg and 2kg.



The acceleration of the system is:

(A) g (B) $\frac{7}{3}g$ (C) $\frac{3}{7}g$ (D) $\frac{1}{7}g$

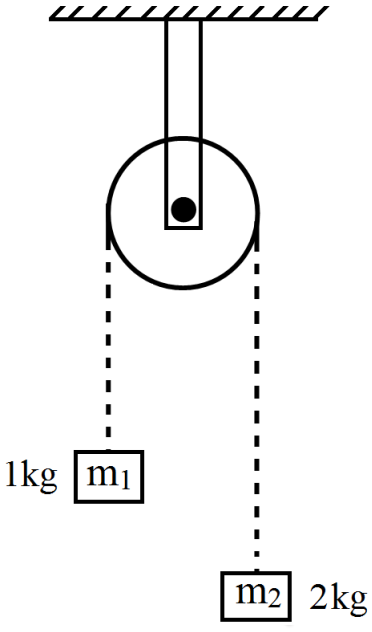
7. A trolley is carrying a box on its surface having coefficient of static friction equal to 0.3. Now the trolley starts moving with increasing acceleration. Find the maximum acceleration of the trolley so that the box does not slide back on the trolley.

(A) $2ms^{-2}$ (B) $3ms^{-2}$ (C) $4ms^{-2}$ (D) $5ms^{-2}$

8. A particle of man 2kg is moving on a circular path of radius 10m with a speed of 5ms and its speed is increasing at rate of $3ms^{-1}$. Find the force acting on the particle.

(A) 5N (B) 10N (C) 12N (D) 14N

9. Two masses m_1= 1kg and m_2 = 2kg are connected by a light inextensible string and suspended by means of a weightless pulley as shown in figure,



Assuming that both the masses start from rest, the distance travelled by 2kg mass in 2s is:

(A) $\frac{20}{9}m$ (B) $\frac{40}{9}m$

(C) $\frac{20}{3}m$ (D) $\frac{1}{3}m$

10. If a car is moving in uniform circular motion, then what should be the value of velocity of a car, so that car will not moving away from the circle,

(A) $v < \sqrt{\mu_s Rg}$

(B) $v \leq \sqrt{\mu_s Rg}$

(C) $v < \sqrt{\mu_k Rg}$

(D) None of these.

11. The dimension of Impulse is:

(A) MLT^{-2} (B) MLT^{-1} (C) MLT^{-3} (D) MLT

12. A body with mass 5kg is acted upon by a force $F = (-3\hat{i} + 4\hat{j})N$. If its initial velocity at t = 0 is $v = (6\hat{i} - 12\hat{j})m\ s^{-1}$, the time at which it will just have a velocity along the y-axis is:

(A) never (B) 10s (C) 2s (D) 15s

13. A particle of mass 10kg is moving in a straight line. If its displacement, x with time t is given by $x = (t^3 - 2t - 10)m$, then the force acting on it at the end of 4 seconds is:

(A) 24N (B) 240N

(C) 300N (D) 1200N

14. A particle is moving on a circular path of 10m radius. At any instant of time, its speed is $5ms^{-1}$ and the speed is increasing at a rate of $2ms^{-2}$. The magnitude of net acceleration at this instant is:

(A) $5ms^{-2}$ (B) $2ms^{-2}$ (C) $3.2ms^{-2}$ (D) $4.3ms^{-2}$

15. A machine gun fires a bullet of mass 40gm with a velocity 1200m/ s. The man holding it can exert a maximum force of 144N on the gun. How many bullets can he fire per second at the most?

(A) Only one.

(B) Three.

(C) He can fire any number of bullets.

(D) 144 × 48

16. An insect is crawling up on the concave surface of a fixed hemispherical bowl of radius R. If the coefficient of friction is $\frac{1}{3}$ then the height up to which the insect can crawl is nearly:

(A) 5% of R. (B) 6% of R. (C) 6.5% of R. (D) 7.5% of R.

17. Two forces $F_1 = 3\hat{i} - 4\hat{j}$ and $F_2 = 2\hat{i} - 3\hat{j}$ are acting upon a body of mass 2kg. Find the force F, which when acting on the body will make it stable.

(A) $5\hat{i} + 7\hat{j}$ (B) $-5\hat{i} - 7\hat{j}$

(C) $-5\hat{i} + 7\hat{j}$ (D) $5\hat{i} - 7\hat{j}$

18. A force of 200N is required to push a car of mass 500kg slowly at constant speed on a level road. If a force of 500N is applied, the acceleration of the car (in ms^{-2}) will be:

(A) Zero. (B) 0.2 (C) 0.6 (D) 1.0

19. 25N force is required to raise 75kg mass from a pulley. If rope is pulled 12m, then the load is lifted to 3m, the efficiency of pulley system will be,

(A) 25% (B) 33.3% (C) 75% (D) 90%

20. A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. Force P is applied at one end of the rope. The force which the rope exerts on the block is:

(A) $\frac{P}{M - m}$ (B) $\frac{PM}{m + M}$ (C) $\frac{P}{M(m + M)}$ (D) $\frac{Pm}{M - m}$

21. Physical independence of force is a consequence of:

(A) Third law of motion.

(B) Second law of motion.

(C) First law of motion.

(D) All of these laws.

22. A shell is fired from a cannon, it explodes in mid air, its total:

(A) Momentum increases.

(B) Momentum decreases.

(C) K.E. increases.

(D) K.E. decreases.

23. A body of mass 10kg is acted upon by two perpendicular forces, 6N and 8N. The resultant acceleration of the body is:

(A) 1m s^{-2} at an angle of 1 4 $\tan^{-1}\left(\frac{4}{3}\right)$ w.r.t. 6N force.

(B) 0.2m s^{-2} at an angle of $\tan^{-1}\left(\frac{4}{3}\right)$ w.r.t. 6N force.

(C) 1m s^{-2} at an angle of $\tan^{-1}\left(\frac{4}{3}\right)$ w.r.t.8N force.

(D) 0.2m s^{-2} at an angle of $\tan^{-1}\left(\frac{4}{3}\right)$ w.r.t.8N force.

24. A 7kg object is subjected to two forces (in Newton) $\vec{F}_1 = 20\hat{i} + 30\hat{j}$ and $\vec{F}_2 = 8\hat{i} - 5\hat{j}$ The magnitude of resulting acceleration in ms^{-2} will be:

(A) 5 (B) 4 (C) 3

25. The coefficient of friction between tyres and the road is 0.1. Find the maximum speed allowed by traffic police for cars to cross a circular turn of radius 10m to prevent accident.

(A) $\sqrt{10}\,ms^{-1}$ (B) $\sqrt{20}\,ms^{-1}$

(C) $5ms^{-1}$

26. A particle of mass 5 kg is pulled along a smooth horizontal surface by a horizontal string. The acceleration of the particle is 10 ms^{-2}. The tension in the string is

(A) 2N (B) 50N (C) 15N

27. When a car is taking a circular turn on a horizontal road, the centripetal force is the force of:

(A) Friction.

(B) Weight of the car.

(C) Weight of the tyres.

28. A 60kg man pushes a 40kg man by a force of 60N. The 40kg man has pushed the other man with a force of:

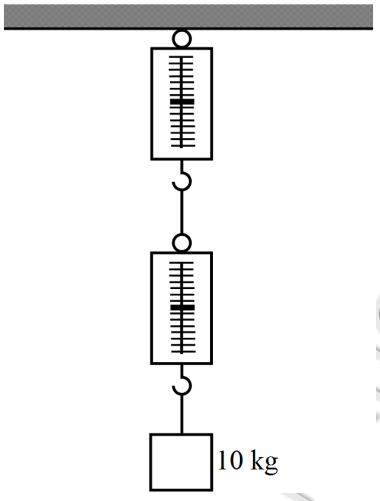
a. 40N
b. 0N
c. 60N
d. 20N

29. A neutron exerts a force on a proton which is:
a. Gravitational.
b. Electromagnetic.
c. Nuclear.
d. Weak.

30. If all matters were made of electrically neutral particles such as neutrons:
a. There would be no force of friction.
b. There would be no tension in the string.
c. It would not be possible to sit on a chair.
d. The earth could not move around the sun.

31. A body of weight w_1 is suspended from the ceiling of a room through a chain of weight w_2. The ceiling pulls the chain by a force:
a. w_1
b. w_2
c. $w_1 + w_2$
d. $\frac{w_1+w_2}{2}$

32. A block of mass 10kg is suspended through two light spring balances as shown in figure:

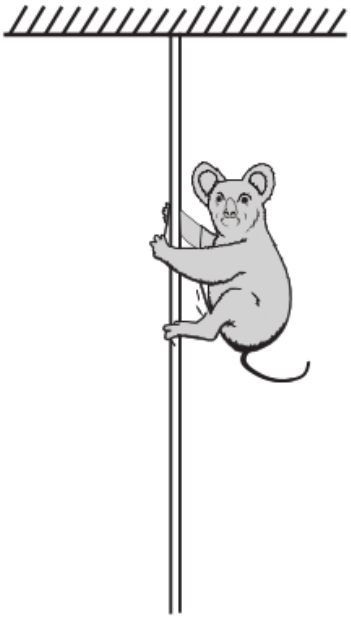


a. Both the scales will read 10kg.
b. Both the scales will read 5kg.
c. The upper scale will read 10kg and the lower zero.
d. The readings may be anything but their sum will he 10kg.

*** Answer The Following Questions In One Sentence.[1 Marks Each] [11]**

33. 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 $0.15kg$, determine the impulse imparted to the ball. (Assume linear motion of the ball)

34. A monkey of mass 40kg climbs on a rope (Fig.) which can stand 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).

35. Two objects having different masses have same momentum.Which one of them will move faster?

36. Two masses are in the ratio 1 : 5. What is the ratio of their inertia?

37. What is the acceleration of a train travelling at $50ms^{-1}$ as it goes round a curve of 250m radius?

38. Calculate the force acting on a body whose linear momentum changes from 20kg ms^{-1} to 40kg ms^{-1} in 10s.

39. What is the apparent weight of a man of mass 60kg who is standing on a lift which is moving up with a uniform speed? ($g = 10ms^{-2}$)

40. A ball moving with a momentum of 5kg ms^{-1} strikes against a wall at an angle of 45° and is reflected at the same angle and with same speed. Find the change in momentum of the ball.

41. A heavy point mass tied to the end of string is whirled in a horizontal circle of radius 20cm with a constant angular speed. What is angular speed if the centripetal acceleration is 980cm/ s^{-2}?

42. A body of mass 25g is moving with a constant velocity of 5m/ sec on a horizontal frictionless surface in vacuum. What is the force acting on the body?

43. A stone is fastened to one end of a string and is whirled in a vertical circle of radius R. Find the minimum speed the stone can have at the highest point of the circle.

*** Given Section consists of questions of 2 marks each. [28]**

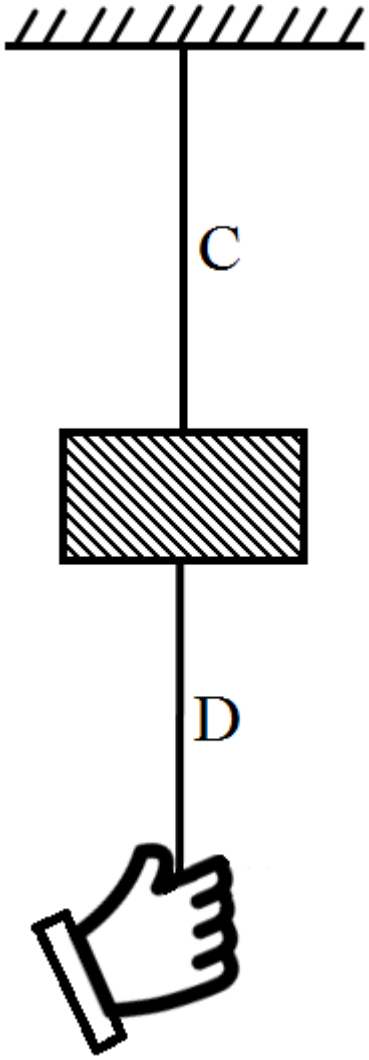
44. A bullet of mass $0.04kg$ moving with a speed of $90ms^{-1}$ enters a heavy wooden block and is stopped after a distance of $60cm$. What is the average

resistive force exerted by the block on the bullet?

45. Define centripetal force. A cyclist speeding at 18km/ hr on a level road takes a sharp circular turn of radius 3m without reducing the speed. The coefficient of static friction is 0.1. Will the cyclist slip while taking the turn?

46. A car of mass 1000kg moving with a speed of $30ms^{-1}$ collides with the back of a stationary lorry of mass 9000kg. (Fig.). Calculate the speed of the vehicles immediately after the collision if they remain jammed together.

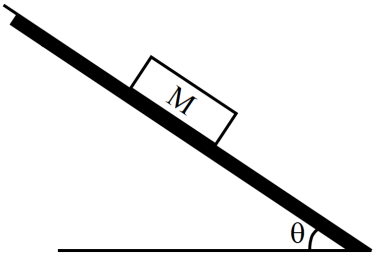
47. A block is supported by a cord C from a rigid support, and another cord D is attached to the bottom of the block. If you give a sudden jerk to D, it will break. But if you pull on D



steadily, C will break. Why?

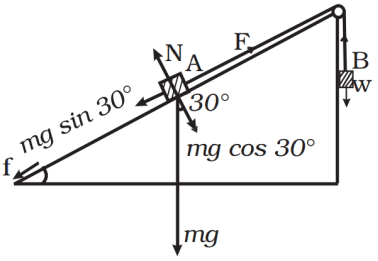
48. A hammer of mass 1kg strikes on the head of a nail with a velocity of 10m s^{-1}7.It drives the nail 1cm into a wooden block. Calculate the force applied by the hammer and the time of impact.

49. A block of mass M is placed on a frictionless, inclined plane of angle θ, as shown in the figure. Determine the acceleration of the block after it is released. What is force

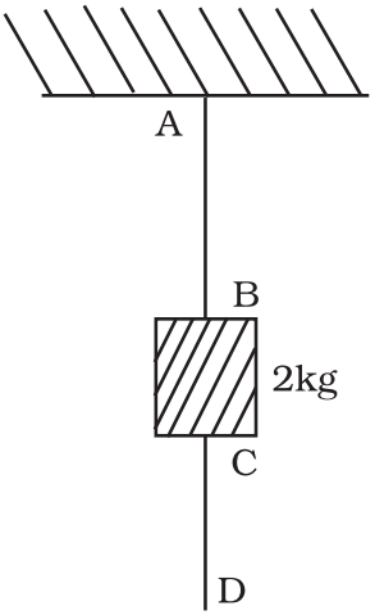


exerted by the incline on the block?

50. Block A of weight 100N rests on a frictionless inclined plane of slope angle 30° A flexible cord attached to A passes over a frictonless pulley and is connected to block B of weight W. Find the weight W for which the system is in equilibrium.



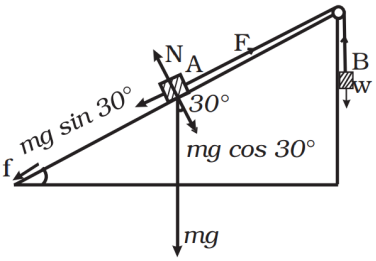
51. A mass of 2kg is suspended with thread AB Thread CD of the same type is attached to the other end of 2kg mass. Lower thread is pulled gradually, harder and harder in the downward directon so as to apply force on AB. Which of the threads will break and why?



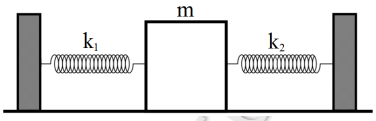
52. A person of mass 50kg stands on a weighing scale on a lift. If the lift is descending with a downward acceleration of 9m s^{-2}, what would be the reading of the weighing scale? (g = 10m s^{-2})

53. A woman throws an object of mass 500g with a speed of 25m s^{1}. What is the impulse imparted to the object?

54. Block A of weight 100N rests on a frictionless inclined plane of slope angle 30° A flexible cord attached to A passes over a frictonless pulley and is connected to block B of weight W. Find the weight W for which the system is in equilibrium.



55. Both the springs shown in figure are unstretched. If the block is displaced by a distance x and released, what will be the initial acceleration?



56. A block of mass 0.2kg is suspended from the ceiling by a light string. A second block of mass 0.3kg is suspended from the first block through another string. Find the tensions in the two strings. Take g = 10m/s^2.

57. A car moving at 40km/h is to be stopped by applying brakes in the next 4.0m. If the car weighs 2000kg, what average force must be applied on it?

*** Given Section consists of questions of 3 marks each.** **[129]**

58. See Fig. 4.11. A mass of 4 kg rests on a horizontal plane. The plane is gradually inclined until at an angle θ = 15° with the horizontal, the mass just begins to slide. What is the coefficient of static friction between the block and the surface ?

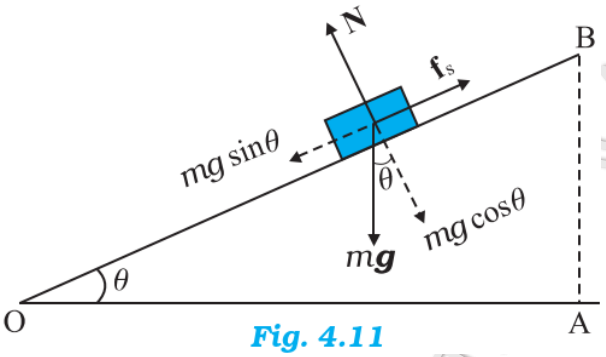
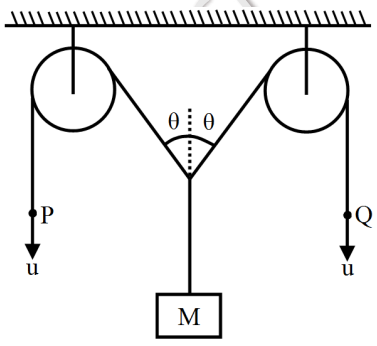


Fig. 4.11

59. In the given arrangement, if the points P and Q move down with a velocity u, find the velocity of M?



60. A ball moving with a momentum of 15kg ms^{-1} strikes against the wall at an angle of 30° and is reflected with the same momentum at the same angle. Calculate impulse.

61. A cricket ball of mass 150g is moving with a velocity of 12ms^{-1} and is hit by a bat so that the ball is turned back with a velocity of 20ms^{-1}. The force of the blow acts for 0.01s. Find the average force exerted on the ball by the bat.

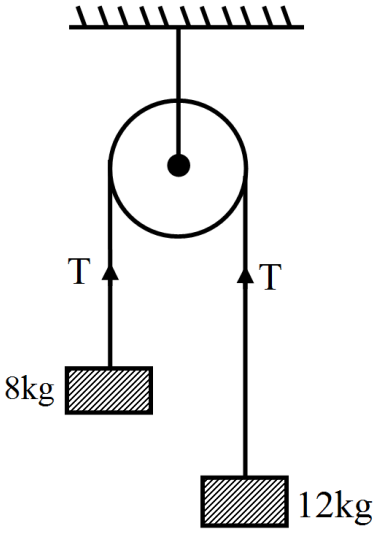
62. A bomb at rest explodes into three parts of the same mass. The moments of the two parts is $-2p_i$ and p_j. What will be the momentum of the third part?

63. A body of mass 2kg is being dragged with a uniform velocity of $2ms^{-1}$ on a rough horizontal plane. The coefficient of friction between the body and the surface is 0.2. Calculate the amount of heat generated per second. Take $g = 9.8ms^{-2}$ and $J = 4.2J/ cal^{-1}$.

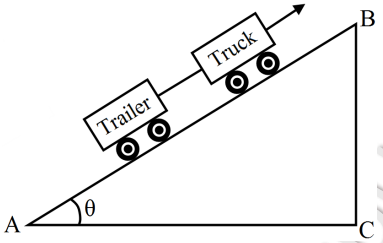
64.

a. Explain the term impulse. Show that impulse of a variable force is equal to the area enclosed by the force-time curve.

b. Two masses 8kg and 12kg are connected at the two ends of a light inextensible string that passes over a frictionless pulley. Find the acceleration of the masses and tension in the string, when the masses are released.



65. A truck tows a trailer of mass 1200kg at a speed of $10ms^{-1}$ on a level road. The tension in the coupling is 1000N. What is the power extended on the trailer? Find the tension in the coupling when the truck ascends a road having an inclination of 1 in 6. Assume that the frictional resistance on the inclined plane is the same as that on the level road.



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

67. A man of mass 70kg stands on a weighing scale in a lift which is:

a. Moving upwards with a uniform speed of 10m/ s.

b. Moving down with a uniform acceleration of $5m/ s^2$.

c. Freely falling under gravity.

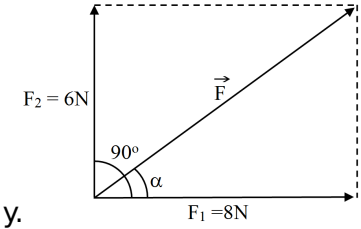
What would be reading on the scale in each case?

68. Two mutually perpendicular forces of 8N and 6N acts on the same body of mass 10kg. Calculate

i. Net force acting on the body,

ii. Magnitude of the acceleration of the body,

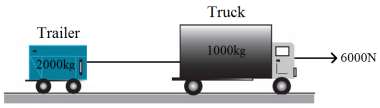
iii. Direction of acceleration of the body.



69. A truck of mass 1000kg is pulling a trailer of mass 2000kg as shown. The retarding (frictional) force on the truck is 500N and that on the trailer is 1000N. The truck engine exerts a force of 6000N. Calculate:

i. The acceleration of the truck and the trailer.

ii. The tension in the connecting rope.



70. A man of mass 70kg stands on a weighing scale in a lift which is moving. Upwards with a uniform acceleration of 5ms^{-2}. What would be the readings on the scale in each case?

71. See Fig. 4.8. A mass of $6kg$ is suspended by a rope of length $2m$ from the ceiling. A force of $50N$ in the horizontal direction is applied at the midpoint P of the rope, as shown. What is the angle the rope makes with the vertical in equilibrium? (Take $g = 10ms^{-2}$). Neglect the mass of the rope.

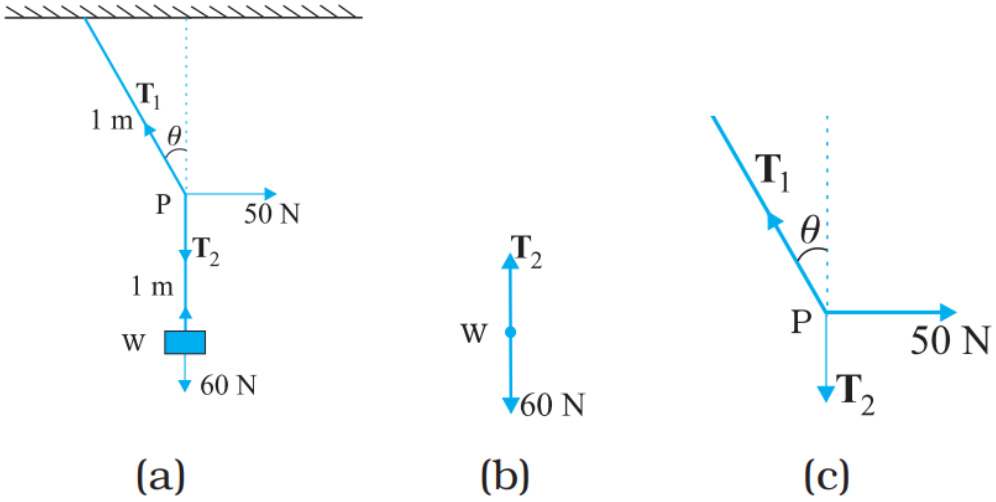


Fig. 4.8

72. A man of mass 70kg stands on a weighing scale in a lift which is moving. What would be the reading if the lift mechanism failed and it hurtled down freely under gravity?

73. A rocket with a lift-off mass 20,000kg is blasted upwards with an initial acceleration of 5.0ms^{-2}. Calculate the initial thrust (force) of the blast.

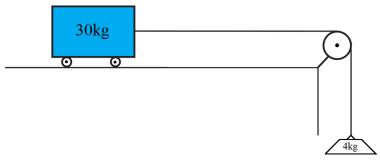
74. A bob of mass 0.1kg hung from the ceiling of a room by a string 2m long is set into oscillation. The speed of the bob at its mean position is 1ms^{-1} . What is the trajectory of the bob if the string is cut when the bob is (a) at one of its extreme positions, (b) at its mean position.

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

76. A man of mass 70kg stands on a weighing scale in a lift which is moving. Upwards with a uniform acceleration of $5ms^{-2}$. What would be the readings on the scale in each case?

77. A cricket ball of mass 150g is moving with a velocity of $12ms^{-1}$, and is hit by a bat, so that the ball is turned back with a velocity of $20ms^{-1}$. The force of the blow acts for 0.01s on the ball. Find the average force exerted by the bat on the ball.

78. Compute the acceleration of the block and trolley system as shown. If the coefficient of kinetic friction between the trolley and the surface is 0.04, what is the tension in the string? [Take g = $10ms^{-2}$]



79. The barrel of a gun is 1m long and it fires a bullet of mass 0.05kg with a muzzle velocity of $400ms^{-1}$. Find:
    a. The acceleration,
    b. The force, and
    c. The impulse given to the bullet by the gun.

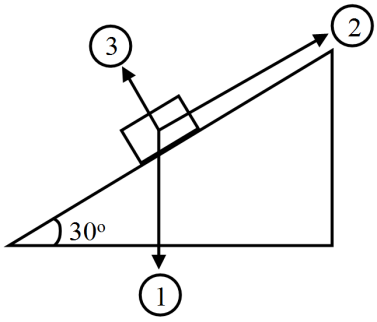
80. Define the term 'coefficient of limiting friction' between two surfaces. A body of mass 10kg is placed on an inclined surface of angle 30°. If the coefficient of limiting friction is $\frac{1}{\sqrt{3}}$ find the force required to just push the body up the inclined surface. The force is being applied parallel to the inclined surface.

81. Define impulse. A cricket ball of mass 150gm moving with speed of 12m/ s is hit by a bat so that the ball is turned back with a velocity of 20m/ s. Calculate the impulse received by the ball.

82. State law of conservation of momentum and prove it using third law of motion.

83. A motor car is travelling at 30m/ s on a circular road of radius 500m. It is increasing its speed at the rate of $2ms^2$. What is the acceleration?

84. A block of wood of mass 3kg is resting on the surface of a rough inclined surface,



inclined at an angle θ as shown in the figure:
    a. Name the forces (1, 2, 3).
    b. If the coefficient of static friction is 0.2, calculate the value of all the three forces. (may use g = 10m/ s^2)

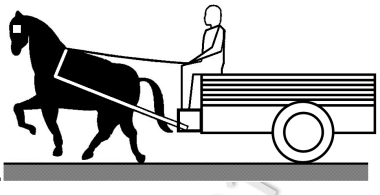
85. Two masses m_1 and m_2 are connected to the ends of a string passing over a pulley. Find the tension and acceleration associated.

86. A cyclist goes round a circular track of 440 metres length in 20 seconds. Find the angle that the cycle makes with the vertical.

87. A woman throws an object of mass 500g with a speed of 25m s^1. If the object hits a wall and rebounds with half the original speed, what is the change in momentum of the object?

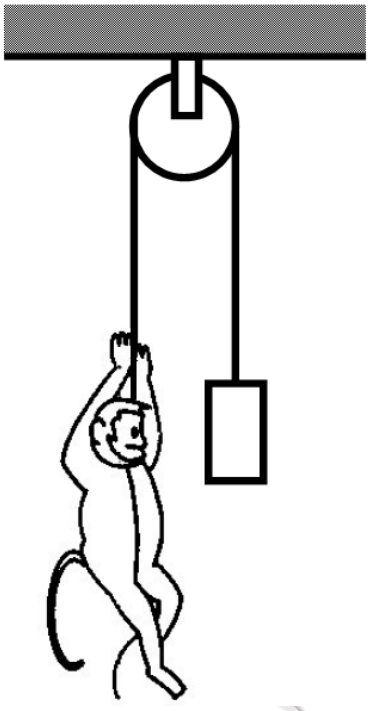
88. The displacement vector of a particle of mass m is given by $\mathrm{r(t)} = \hat{\mathrm{i}}\mathrm{A}\cos\omega\mathrm{t} + \hat{\mathrm{j}}\mathrm{B}\sin\omega\mathrm{t}$. Show that the trajectory is an ellipse.

89. The gravitational force acting on a particle of 1g due to a similar particle is equal to 6.67×10^{-17}N. Calculate the separation between the particles.

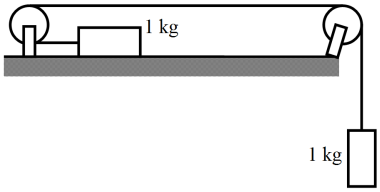


90. Figure shows a cart. Complete the table shown.

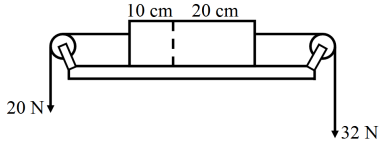
91. A monkey is climbing on a rope that goes over a smooth light pulley and supports a block of equal mass at the other end figure. Show that whatever force the monkey exerts on the rope, the monkey and the blockmove in the same direction with equal acceleration. If initially both were at rest, their separation will not change as time passes.



92. Calculate the tension in the string shown in figure. The pulley and the string are light and all surfaces are frictionless. Take g = 10m/s^2.

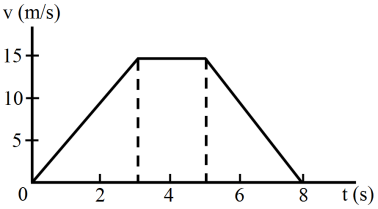


93. Figure shows a uniform rod of length 30cm having a mass of 3.0kg. The strings shown in the figure are pulled by constant forces of 20N and 32N. Find the force exerted by the 20cm part of the rod on the 10cm part. All the surfaces are smooth and the strings and the pulleys are light.



94. A monkey of mass 15kg is climbing on a rope with one end fixed to the ceiling. If it wishes to go up with an acceleration of $1 m/s^2$, how much force should it apply to the rope? If the rope is 5m long and the monkey starts from rest, how much time will it take to reach the ceiling?

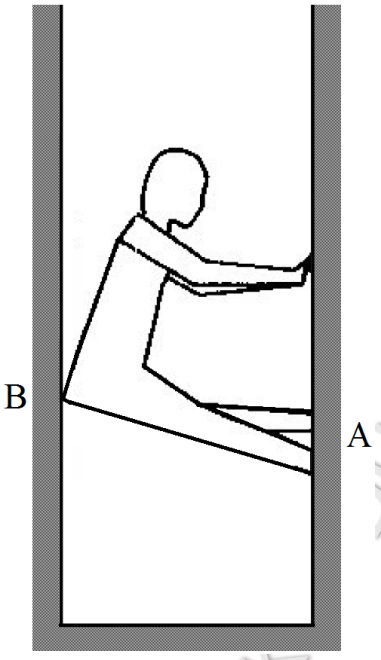
95. A particle of mass 50g moves on a straight line. The variation of speed with time is shown in figure. Find the force acting on the particle at t = 2, 4 and 6 seconds.



96. A block of 2kg is suspended from the ceiling through a massless spring of spring constant k = 100N/m. What is the elongation of the spring? If another 1kg is added to the block, what would be the further elongation?

97. A block is projected along a rough horizontal road with a speed of 10m/s. If the coefficient of kinetic friction is 0.10, how far will it travel before coming to rest?

98. A person (40kg) is managing to be at rest between two vertical walls by pressing one wall A by his hands and feet and the other wall B by his back. Assume that the friction coefficient between his body and the walls is 0.8 and that limiting friction acts at all the contacts.
    a. Show that the person pushes the two walls with equal force.
    b. Find the normal force exerted by either wall on the person. Take $g = 10 m/s^2$.



99. A simple pendulum is suspended from the ceiling of a car taking a turn of radius 10m at a speed of 36km/ h. Find the angle made by the string of the pendulum with the vertical if this angle does not change during the turn. Take $g = 10 m/s^2$.

100. A particle moves in a circle of radius 1.0cm at a speed given by v = 2.0t where v is in cm/s and t in seconds.
    a. Find the radial acceleration of the particle at t = 1s.
    b. Find the tangential acceleration at t = 1s.

c. Find the magnitude of the acceleration at t = 1s.

*** Given Section consists of questions of 5 marks each.** **[230]**

101. 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. It is easier to pull a lawn mower than to push it.
   d. A cricketer moves his hands backwards while holding a catch.

102. A stream of water flowing horizontally with a speed of $15ms^{-1}$ gushes out of a tube of cross-sectional area $10^{-2}m^2$, and hits a vertical wall nearby. What is the force exerted on the wall by the impact of water, assuming it does not rebound?

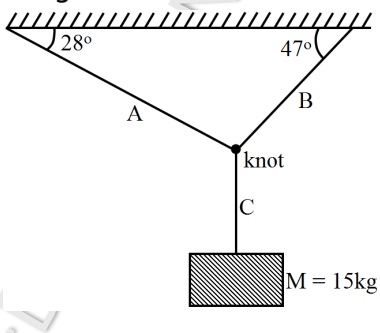
103. A stone of mass m tied to the end of a string revolves in a vertical circle of radius R. The net forces at the lowest and highest points of the circle directed vertically downwards are: [Choose the correct alternative]

	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 corresponding values at the highest point.

104. A disc revolves with a speed of $33\frac{1}{3}\text{rev}/\text{min}$, and has a radius of 15cm. Two coins are placed at 4cm and 14cm away from the centre of the record. If the co-efficient of friction between the coins and the record is 0.15, which of the coins will revolve with the record?

105. A block of mass 15kg hangs from three chords as shown in figure. What are the tensions in the chords?

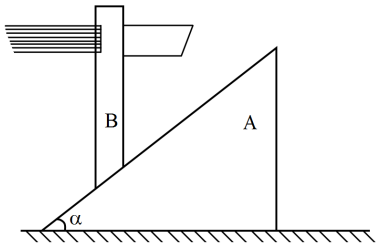


106. A helicopter of mass 2000kg rises with a vertical acceleration of $15m\ s^{-2}$. The total mass of the crew and passengers is 500kg. Give the magnitude and direction of the ($g = 10m\ s^{-2}$)
   a. Force on the floor of the helicopter by the crew and passengers.
   b. Action of the rotor of the helicopter on the surrounding air.
   c. Force on the helicopter due to the surrounding air.

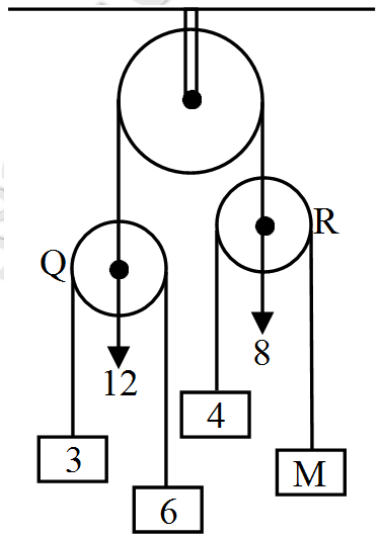
107. State Newton's Second law of motion. Prove that second law is the real law of motion.

108. A shell of mass 0.020kg is fired by a gun of mass 100kg. If the muzzle speed of the shell is $80ms^{-1}$, what is the recoil speed of the gun?

109. Find the acceleration of rod B and wedge A in the arrangement shown in figure, if the ratio of the mass of wedge to that of rod equals n and there is no friction between any contact surfaces.

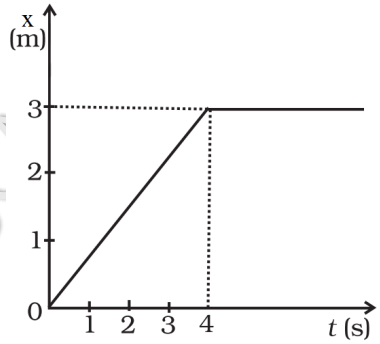


110. Two pulleys of masses 12kg and 8kg are connected by a fine string hanging over a fixed pulley as shown. Over the 8kg pulley is hung a fine string with masses 4kg and M. Over the 12kg pulley is hung another fine string with masses 3kg and 6kg. Calculate M so that the string over the fixed pulley remains stationary.



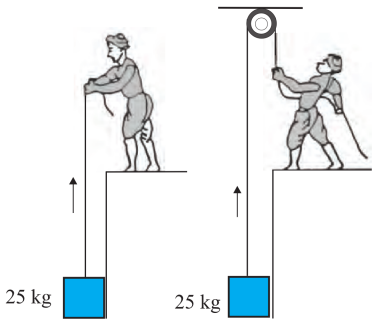
111. A machine gun has a mass of 20kg. It fires 35g bullets at the rate of 400 bullets per second with a speed of 400ms^{-1}. What force must be applied to the gun to keep it in position?

112. The position time graph of a body of mass 2kg is as given in What is the impulse on the body at t = 0 s and t = 4s.



113. Two bodies of masses 10kg and 20kg respectively kept on a smooth, horizontal surface are tied to the ends of a light string. A horizontal force F = 600N is applied to (i) A, (ii) B along the direction of string. What is the tension in the string in each case?

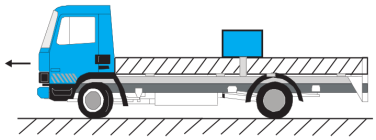
114. A block of mass 25kg is raised by a 50kg man in two different ways as shown in Fig. What is the action on the floor by the man in the two cases? If the floor yields to a normal force of 700N, which mode should the man adopt to lift the block without the



floor yielding?

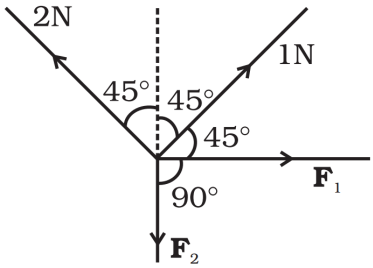
115. A disc revolves with a speed of $33\frac{1}{3}\text{rev/min}$, and has a radius of 15cm. Two coins are placed at 4cm and 14cm away from the centre of the record. If the co-efficient of friction between the coins and the record is 0.15, which of the coins will revolve with the record?

116. The rear side of a truck is open and a box of 40kg mass is placed 5m away from the open end as shown in Fig. 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).

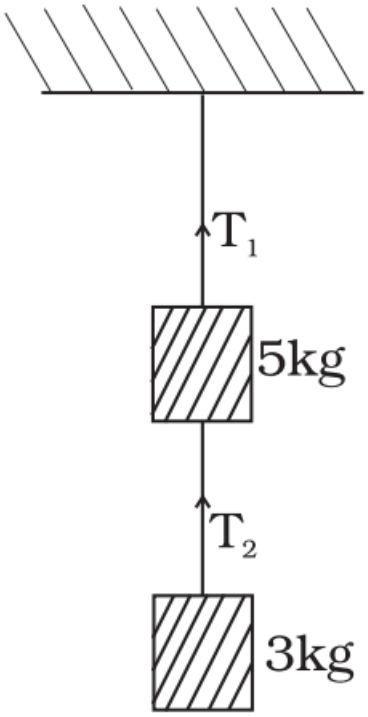


117. A helicopter of mass 1000kg rises with a vertical acceleration of $15ms^{-2}$. The crew and the passengers weigh 300kg. Give the magnitude and direction of the,
   a. Force on the floor by the crew and passengers.
   b. Action of the rotor of the helicopter on the surrounding air.
   c. Force on the helicopter due to the surrounding air.

118. There are four forces acting at a point P produced by strings as shown in which is at rest. Find the forces F_1 and F_2.

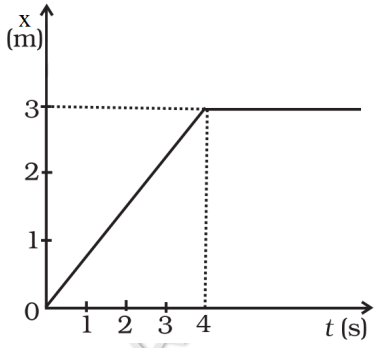


119. Two masses of 5kg and 3kg are suspended with help of massless inextensible strings as shown in Calculate T_1 and T_2 when whole system is going upwards with acceleration



= 2m s^2 (use g = 9.8m s^{-2}).

120. The position time graph of a body of mass 2kg is as given in What is the impulse on the body at t = 0 s and t = 4s.

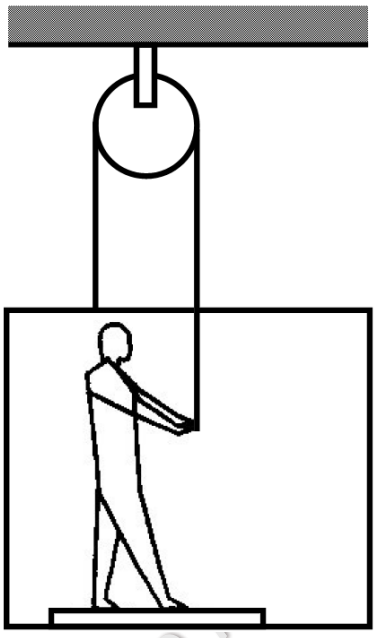


121. A helicopter of mass 2000kg rises with a vertical acceleration of 15m s^{-2}. The total mass of the crew and passengers is 500kg. Give the magnitude and direction of the (g = 10m s^{-2})

a. Force on the floor of the helicopter by the crew and passengers.
b. Action of the rotor of the helicopter on the surrounding air.
c. Force on the helicopter due to the surrounding air.

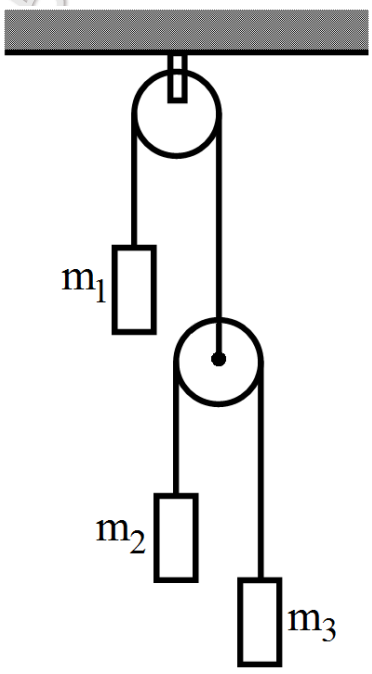
122. A 100kg gun fires a ball of 1kg horizontally from a cliff of height 500m. It falls on the ground at a distance of 400m from the bottom of the cliff. Find the recoil velocity of the gun. (acceleration due to gravity = 10m s^{-2})

123. Figure shows a man of mass 60kg standing on a light weighing machine kept in a box of mass 30kg. The box is hanging from a pulley fixed to the ceiling through a light rope, the other end of which is held by the man himself. If the man manages to keep the box at rest, what is the weight shown by the machine? What force should he exert on the



rope to get his correct weight on the machine?

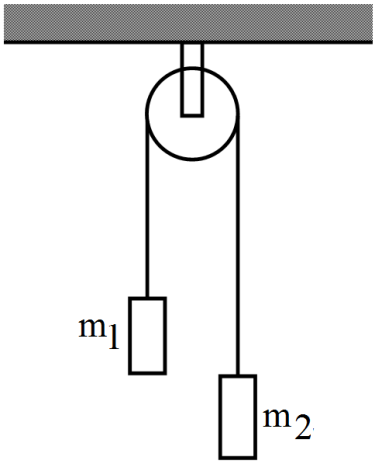
124. Let m_1 = 1kg, m_2 = 2kg and m_3 = 3kg in figure. Find the accelerations of m_1, m_2 and m_3. The string from the upper pulley to m_1 is 20cm when the system is released from



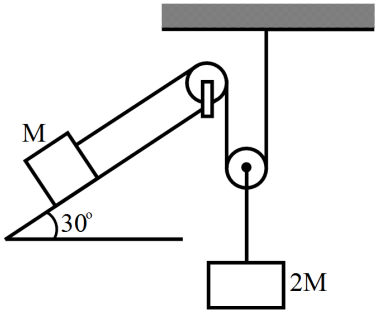
rest. How long will it take before m, strikes the pulley?

125. In a simple Atwood machine, two unequal masses m_1 and m_2 are connected by a string going over a clamped light smooth pulley. In a typical arrangement m_1 = 300g and m_2 = 600g. The system is released from rest.

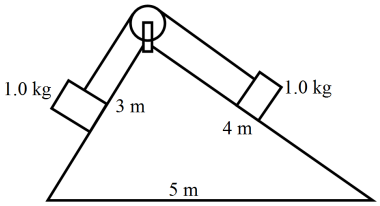
a. Find the distance travelled by the first block in the first two seconds.
b. Find the tension in the string.
c. Find the force exerted by the clamp on the pulley.



126. Find the acceleration of the block of mass M in the situation shown in figure. All the surfaces are frictionless and the pulleys and the string are light.

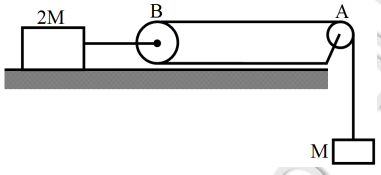


127. Consider the situation shown in figure. All the surfaces are frictionless and the string and the pulley are light. Find the magnitude of the acceleration of the two blocks.

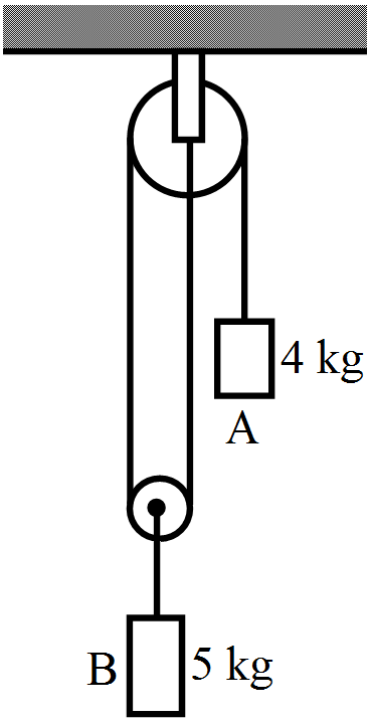


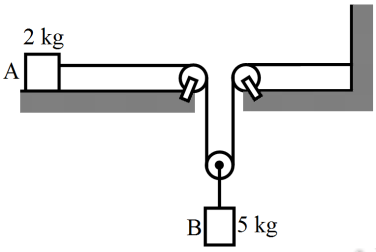
128. Consider the situation shown in figure. Both the pulleys and the string are light and all the surfaces are frictionless.

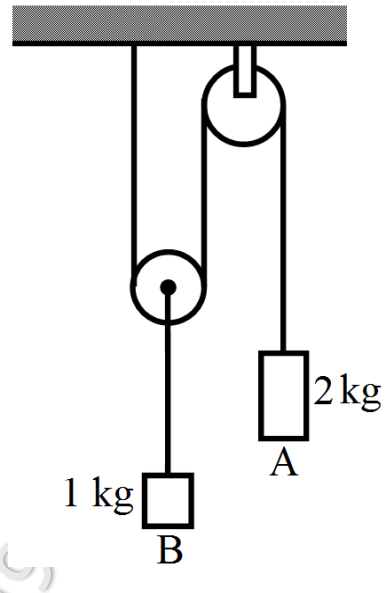
a. Find the acceleration of the mass M.
b. Find the tension in the string.
c. Calculate the force exerted by the clamp on the pulley A in the figure.



129. Find the acceleration of the blocks A and B in the three situations shown in figure.

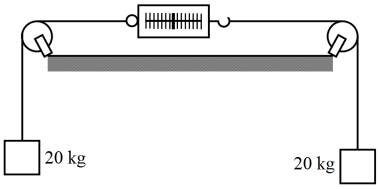




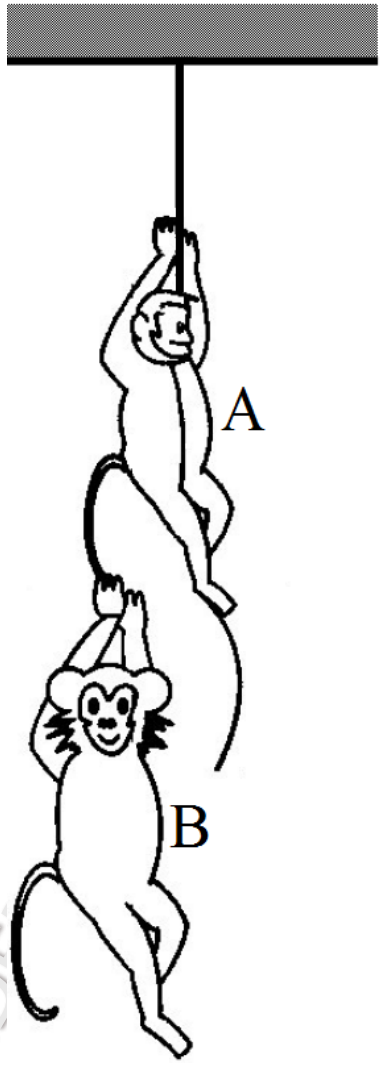


130. Figure shows a light spring balance connected to two blocks of mass 20kg each. The graduations in the balance measure the tension in the spring.

a. What is the reading of the balance?
b. Will the reading change if the balance is heavy, say 2.0kg?
c. What will happen if the spring is light but the blocks have unequal masses?



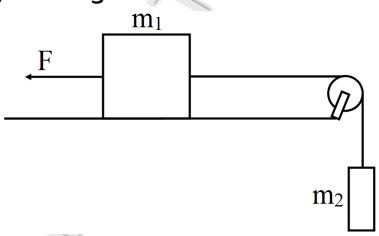
131. The monkey B shown in figure is holding on to the tail of the monkey A which is climbing up a rope. The masses of the monkeys A and B are 5kg and 2kg respectively. If A can tolerate a tension of 30N in its tail, what force should it apply on the rope in order



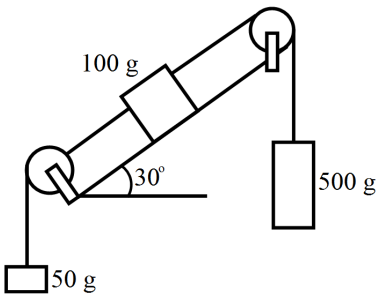
to carry the monkey B with it? Take g = 10m/s^2

132. An empty plastic box of mass m is found to accelerate up at the rate of $\frac{g}{6}$ when placed deep inside water. How much sand should be put inside the box so that it may accelerate down at the rate of $\frac{g}{6}$?

133. A constant force $F = \frac{m_2 g}{2}$ is applied on the block of mass m_1 as shown in figure. The string and the pulley are light and the surface of the table is smooth. Find the

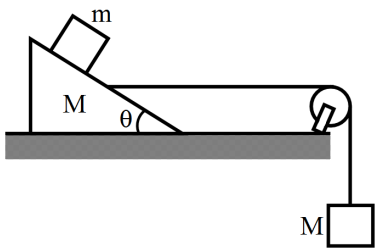


acceleration of m_1.



134. Find the acceleration of the 500g block in figure.

135. Find the mass M of the hanging block in figure which will prevent the smaller block from slipping over the triangular block. All the surfaces are frictionless and the strings

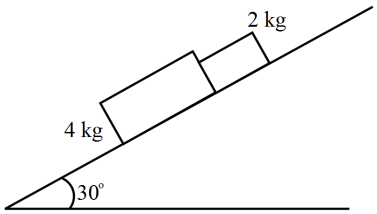


and the pulleys are light.

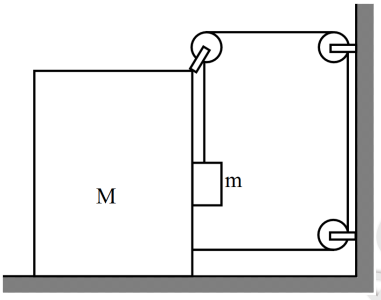
136. Figure shows two blocks in contact sliding down an inclined surface of inclination 30°. The friction coefficient between the block of mass 2.0kg and the incline is μ_1, and that between the block of mass 4.0kg and the incline is μ_2. Calculate the acceleration of the 2.0kg block if:

a. $\mu_1 = 0.20$ and $\mu_2 = 0.30$

b. $\mu_1 = 0.30$ and $\mu_2 = 0.20$ Take $g = 10 m/s^2$.

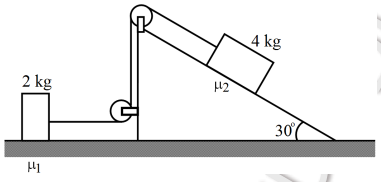


137. Find the acceleration of the block of mass M in the situation of figure. The coefficient of friction between the two blocks is μ_1 and that between the bigger block and the ground is μ_2.

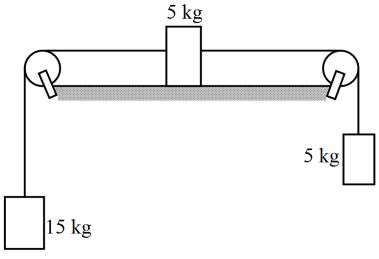


138. The friction coefficient between a road and the tyre of a vehicle is $\frac{4}{3}$. Find the maximum incline the road may have so that once hard brakes are applied and the wheel starts skidding, the vehicle going down at a speed of 36km/hr is stopped within 5m.

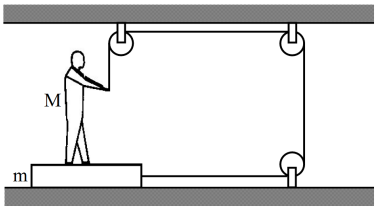
139. If the tension in the string in figure is 16N and the acceleration of each block is 0.5m/s^2, find the friction coefficients at the two contacts with the blocks.



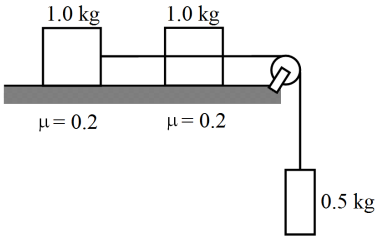
140. The friction coefficient between the table and the block shown in figure is 0.2. Find the tensions in the two strings.



141. The friction coefficient between the board and the floor shown in figure is μ. Find the maximum force that the man can exert on the rope so that the board does not slip on the floor.

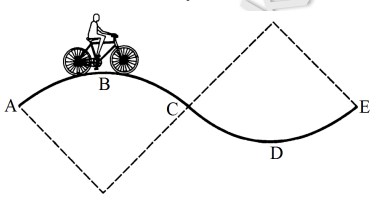


142. Consider the situation shown in figure. Calculate:
   a. The acceleration of the 1.0kg blocks.
   b. The tension in the string connecting the 1.0kg blocks.
   c. The tension in the string attached to 0.50kg.



143. A motorcycle has to move with a constant speed on an overbridge which is in the form of a circular arc of radius R and has a total length L. Suppose the motorcycle starts from the highest point.
   a. What can its maximum velocity be for which the contact with the road is not broken at the highest point?
   b. If the motorcycle goes at speed $\frac{1}{\sqrt{2}}$ times the maximum found in part (a), where will it lose the contact with the road?
   c. What maximum uniform speed can it maintain on the bridge if it does not lose contact anywhere on the bridge?

144. A track consists of two circular parts ABC and CDE of equal radius 100m and joined smoothly as shown in figure. Each part subtends a right angle at its centre. A cycle weighing 100 kg together with the rider travels at a constant speed of 18km/h on the track.
   a. Find the normal contact force by the road on the cycle when it is at B and at D.
   b. Find the force of friction exerted by the track on the tyres when the cycle is at B, C and D.
   c. Find the normal force between the road and the cycle just before and just after the cycle crosses C.
   d. What should be the minimum friction coefficient between the road and the tyre, which will ensure that the cyclist can move with constant speed? Take g= 10m/s^2.



145. A turn of radius 20m is banked for the vehicles going at a speed of 36 km/h. If the coefficient of static friction between the road and the tyre is 0.4, what are the possible speeds of a vehicle so that it neither slips down nor skids up?

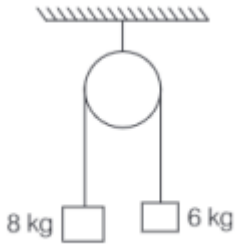
146. A car moving at a speed of 36 km/hr is taking a turn on a circular road of radius 50m. A small wooden plate is kept on the seat with its plane perpendicular to the radius of the circular road (figure In). A small block of mass 100g is kept on the seat which rests against the plate. The friction coefficient between the block and the plate is $\mu = 0.58$.

a. Find the normal contact force exerted by the plate on the block.

b. The plate is slowly turned so that the angle between the normal to the plate and the radius of the road slowly increases. Find the angle at which the block will just start sliding on the plate.

* Case study based questions [20]

147. Read the passage given below and answer the following questions from (i) to (v). Force of Friction on Connected Bodies When bodies are in contact, there are mutual contact forces satisfying the third law of motion. The component of contact force normal to the surfaces in contact is called normal reaction. The component parallel to the surfaces in



contact is called friction In the above figure, 8 kg and 6 kg are hanging stationary from a rough pulley and are about to move. They are stationary due to roughness of the pulley.

i. Which force is acting between pulley and rope?
   a. Gravitational force
   b. Tension force
   c. Frictional force
   d. Buoyant force

ii. The normal reaction acting on the system is
   a. 8g
   b. 6g
   c. 2g
   d. 4g

iii. The tension is more on side having mass of:
   a. 8kg
   b. 6kg
   c. Same on both
   d. Nothing can be said

iv. The force of friction acting on the rope is:
   a. 20N
   b. 30N
   c. 40N
   d. 50N

v. Coefficient of friction of the pulley is
   a. $\frac{1}{6}$

b. $\frac{1}{7}$

c. $\frac{1}{5}$

d. $\frac{1}{4}$

148. Read the passage given below and answer the following questions from (i) to (v).

Momentum and Newton's Second Law of Motion Momentum of a body is the quantity of motion possessed by the body. It depends on the mass of the body and the velocity with which it moves. When a bullet is fired by a gun, it can easily pierce human tissue before coming to rest resulting in casualty. The same bullet fired with moderate speed will not cause much damage. The greater the change in momentum in a given time, the greater is the force that needs to be applied. The second law of motion refers to the general situation, where there is a net external force rating on the body.

i. A satellite in force-free space sweeps stationary interplanetary dust at a rate $\frac{\mathrm{dM}}{\mathrm{dt}} = \mathrm{dv}$, where M is the mass, v is the dt velocity of satellite and a is a constant. What is the deceleration of the satellite?

a. $\frac{-2\mathrm{av}^2}{\mathrm{M}}$

b. $\frac{-\mathrm{av}^2}{\mathrm{M}}$

c. $-\mathrm{av}^2$

d. $\frac{\mathrm{av}^2}{\mathrm{M}}$

ii. A body of mass 5 kg is moving with velocity of $\mathrm{v} = (2\hat{\mathrm{i}} + 6\hat{\mathrm{j}})$ ms^{-1} at t = 0s. After time t = 2s, velocity of body is $(10\hat{\mathrm{i}} + 6\hat{\mathrm{j}})$ ms^{-1}, then change in momentum of body is:

a. $40\hat{\mathrm{i}}\ \mathrm{kg} - \mathrm{ms}^{-1}$

b. $20\hat{\mathrm{i}}\ \mathrm{kg} - \mathrm{ms}^{-1}$

c. $30\hat{\mathrm{i}}\mathrm{kg} - \mathrm{ms}^{-1}$

d. $(50\hat{\mathrm{i}} + 30\hat{\mathrm{j}})\ \mathrm{Kg}$ - ms^{-1}

iii. A cricket ball of mass 0.25kg with speed 10m/ s collides with a bat and returns with same speed with in 0.01s. The force acted on bat is:

a. 25N

b. 50N

c. 250N

d. 500N

iv. A stationary bomb explodes into three pieces. One piece of 2 kg mass moves with a velocity of 8 ms" 1 at right angles to the other piece of mass 1 kg moving with a velocity of 12 ms -1 . If the mass of the third piece is 0.5 kg, then its velocity is:

a. 10ms^{-1}

b. 20ms^{-1}

c. 30ms^{-1}

d. AOms^{-1}

v. A force of 10 N acts on a body of mass 0.5kg for 0.25s starting from rest. What is its momentum now?

a. 0.25 N/ s

b. 2.5 N/ s

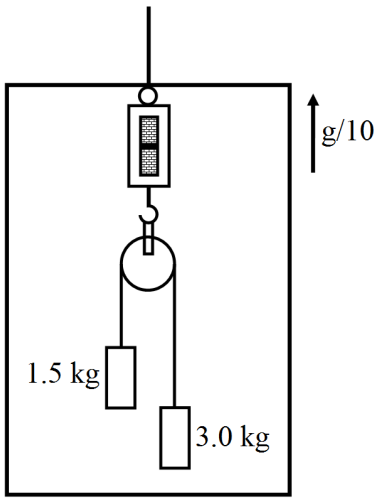
c. 0.5 N/ s

d. 0.75 N/ s

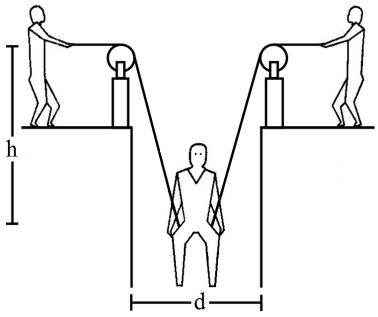
149. A person is standing on a weighing machine placed on the floor of an elevator. The elevator starts going up with some acceleration, moves with uniform velocity for a while and finally decelerates to stop. The maximum and the minimum weights recorded are 72kg and 60kg. Assuming that the magnitudes of the acceleration and the deceleration are the same, find:

a. The true weight of the person.

b. The magnitude of the acceleration. Take g = 9.9m/s^2.



150. A man has fallen into a ditch of width d and two of his friends are slowly pulling him out using a light rope and two fixed pulleys as shown in figure. Show that the force (assumed equal for both the friends) exerted by each friend on the road increases as the man moves up. Find the force when the man is at a depth h.



151. A small coin is placed on a record rotating at $33\frac{1}{3}$ rev/ minute. The coin does not slip on the record. Where does it get the required centripetal force from?

----- जब भी कोई काम करो तो उसे ऐसे करो कि काम को गर्व हो की तुमने उसे किया है। -----