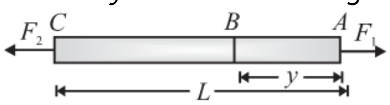
Kattar NEET 2026

Physics by MR Sir

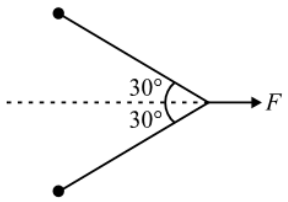
Laws of Motion

Q1 A rod of length L and mass M is acted on by two unequal forces F_1 and F_2 ($<F_1$) as shown in the following figure. The tension in the rod at a distance y from the end A is given by



(A) $F_1\left(1-\frac{y}{L}\right)+F_2\left(\frac{y}{L}\right)$
(B) $F_2\left(1-\frac{y}{L}\right)+F_1\left(\frac{y}{L}\right)$
(C) $\left(F_1-F_2\right)\frac{y}{L}$
(D) $\left(F_1-F_2\right)\frac{y}{2L}$

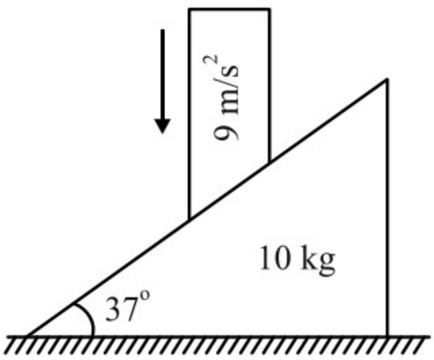
Q2 In figure, two identical particles each of mass m are tied together with an inextensible massless string. This is pulled at its centre with a constant force F *as shown* . If the whole system lies on a smooth horizontal plane, then the acceleration of each particle towards each other is



(A) $\frac{\sqrt{3}}{2}\frac{F}{m}$ (B) $\frac{1}{2\sqrt{3}}\frac{F}{m}$
(C) $\frac{2}{\sqrt{3}}\frac{F}{m}$ (D) $\sqrt{3}\frac{F}{m}$

Q3 A scooter of mass 120 kg is moving with a uniform velocity of 108 km/hr. The constant force required to stop the scooter in 10 s is:
(A) 180 N (B) 208 N
(C) 360 N (D) 720 N

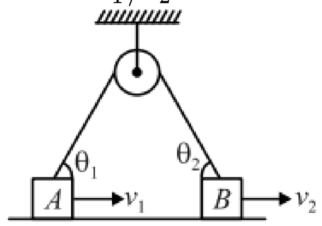
Q4 In the system shown in figure, all surfaces are smooth. Rod is moved by external agent with acceleration $9\ \mathrm{ms}^{-2}$ vertically downwards. Force exerted on the rod by the wedge will be



(A) $120\ \mathrm{N}$ (B) $200\ \mathrm{N}$
(C) $160\ \mathrm{N}$ (D) $180\ \mathrm{N}$

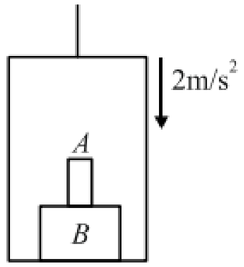
Q5 Three concurrent co-planar forces $1\ \mathrm{N}, 2\ \mathrm{N}$ and $3\ \mathrm{N}$ acting along different directions on a body
(A) can keep the body in equilibrium if $2\ \mathrm{N}$ and $3\ \mathrm{N}$ act at right angle.
(B) can keep the body in equilibrium if $1\ \mathrm{N}$ and $2\ \mathrm{N}$ act at right angle.
(C) cannot keep the body in equilibrium.
(D) can keep the body in equilibrium if $1\ \mathrm{N}$ and $3\ \mathrm{N}$ act at an acute angle.

Q6 In figure, blocks A and B move with velocities v_1 and v_2 along horizontal direction. Find the ratio of v_1/v_2.



(A) $\frac{\sin\theta_1}{\sin\theta_2}$
(B) $\frac{\sin\theta_2}{\sin\theta_1}$
(C) $\frac{\cos\theta_2}{\cos\theta_1}$
(D) $\frac{\cos\theta_1}{\cos\theta_2}$

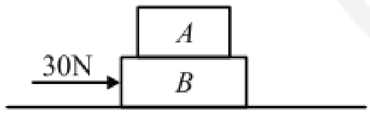
Q7 The elevator shown in figure is descending with an acceleration of $2\ \mathrm{m/s^2}$. The mass of the block A is $0.5\ \mathrm{kg}$. The force exerted by the block A on block B is (Take $g = 10\ \mathrm{m/s^2}$)



(A) $2\ \mathrm{N}$
(B) $4\ \mathrm{N}$
(C) $6\ \mathrm{N}$
(D) $8\ \mathrm{N}$

Q8 A particle of mass $100\ \mathrm{g}$ is suspended from a light string. The string is moved (i) upwards and (ii) downwards with an acceleration of $5\ \mathrm{m/s^2}$. If T_u and T_d are the tensions in the string during upward and downward motions respectively, then $T_u - T_d$ is equal to (given g = 10 m-s^{-2})
(A) $1\ \mathrm{N}$
(B) $0.5\ \mathrm{N}$
(C) $0.98\ \mathrm{N}$
(D) $1.96\ \mathrm{N}$

Q9 A block A of mass $2\ \mathrm{kg}$ rests on another block B of mass $8\ \mathrm{kg}$ which rests on a horizontal floor, as shown in the figure. The coefficient of friction between A and B is 0.2 while that between B and the floor is 0.5. When a horizontal force of $30\ \mathrm{N}$ is applied on B, the force of friction between A and B is (Take $g = 10\ \mathrm{m/s^2}$)

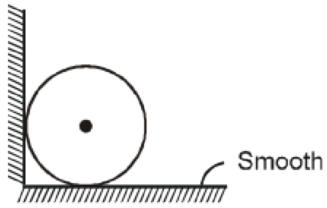


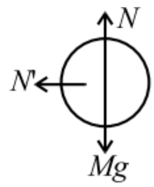
(A) Zero
(B) $4\ \mathrm{N}$
(C) $5\ \mathrm{N}$
(D) $6\ \mathrm{N}$

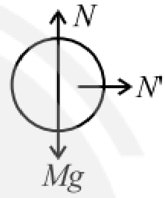
Q10 The linear momentum of a particle is given by $p = a + bt^2$, where t is time and a and b are constants. The force acting on the body varies directly as
(A) t^0
(B) t
(C) t^2
(D) t^3

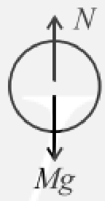
Q11 Which one of the following is not a conservative force?
(A) Force of friction
(B) spring force
(C) Gravitational force
(D) Electrostatic force

Q12 Choose the ***correct*** FBD for the given system



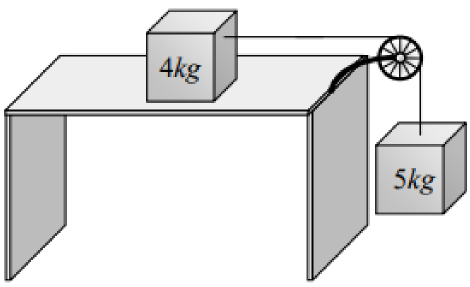
(A)


(B)


(C)


(D) FBD can not be drawn by given figure.

Q13 Two masses of 4 kg and 5 kg are connected by a string passing through a frictionless pulley and are kept on a frictionless table as shown in the figure. The acceleration of 5 kg mass is (g = 9.8 m/s^2)

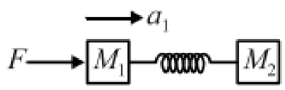


(A) 49 m/s^2
(B) 5.44 m/s^2
(C) 19.5 m/s^2
(D) 2.72 m/s^2

Q14 A rocket of mass 100 kg burns 0.1 kg of fuel per sec. If velocity of exhaust gas is 1 km/sec, then it lifts with an acceleration of

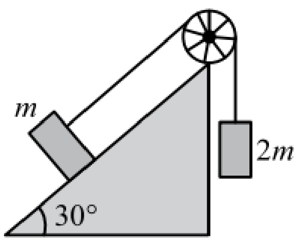
(A) 1000 ms^{-2}
(B) 100 ms^{-2}
(C) 10 ms^{-2}
(D) 1 ms^{-2}

Q15 Two blocks of masses M_1 and M_2 are connected to each other through a light spring as shown in the figure. If we push the mass M_1 with a force F and cause acceleration a_1 in the mass M_1, what will be the acceleration of M_2 ?



(A) $\frac{F}{M_2}$
(B) $\frac{F}{M_1+M_2}$
(C) a_1
(D) $\frac{F-M_1a_1}{M_2}$

Q16 Two blocks of masses *m* and 2*m* are connected by a light string passing over a frictionless pulley. As shown in the figure, the mass *m* is placed on a smooth inclined plane of inclination 30° and 2*m* hangs vertically. If the system is released, the blocks move with an acceleration equal to



(A) $g/4$
(B) $g/3$
(C) $g/2$
(D) g

Q17 One end of a spring balance is stretched by a force of 2 N and an equal and opposite force is applied on its other end. The reading of the spring balance will be

(A) 4 N
(B) 2 N
(C) 1 N
(D) 0

Q18 **Assertion (A):** Impulse and momentum have same dimensions.

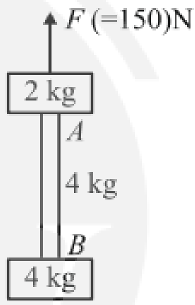
Reason(R): Impulse is equal to change in momentum.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true, but R is not the correct explanation of A.
(C) A is true, but R is false.
(D) A is false, but R is true.

Q19 A vehicle of mass 500 kg is moving with a constant speed 10 m/s. Sand is poured into it at the rate of 12 kg per min. How much force is needed to keep it moving with the same speed?

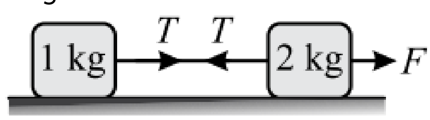
(A) 2 N
(B) 3 N
(C) 0 N
(D) 12 N

Q20 Consider the arrangement shown where two blocks are connected by a uniform rope of mass 4 kg. The arrangement is lifted up vertically by a vertical upward force of 150 N magnitude. The ratio of tension in the rope at A to that at B would be (given g = 10 m-s^{-2})



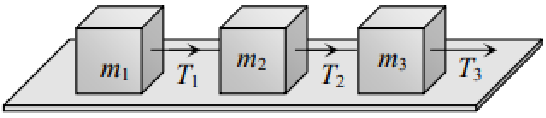
(A) 2
(B) $1/2$
(C) $5/4$
(D) $4/3$

Q21 Two blocks masses 1 kg and 2 kg rest on a smooth horizontal table. When the 2 kg block is pulled by a certain force *F*, the tension *T* in the string is 1.5 N. The value of *F* is



(A) 1.5 N
(B) 2.5 N
(C) 3.5 N
(D) 4.5 N

Q22 Three blocks of masses m_1, m_2 and m_3 are connected by massless strings as shown on a frictionless table. They are pulled with a force T_3 = 40 N. If m_1 = 10 kg, m_2 = 6 kg and m_3 = 4 kg, the tension T_2 will be

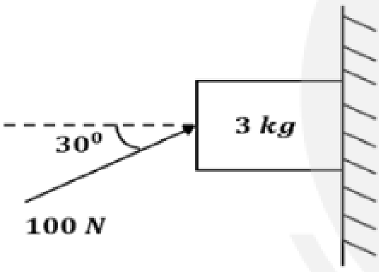


(A) 20 N (B) 40 N
(C) 10 N (D) 32 N

Q23 If a force F is applied on a block of mass m_1, then it produces an acceleration a_1. If the same force is applied to a second block of mass m_2, then it produces an acceleration a_2. If the same force is applied on a block of mass (m_1+m_2), then acceleration is

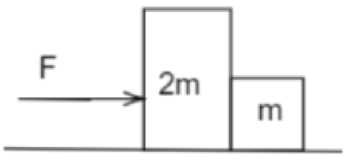
(A) $\frac{a_1 a_2}{a_1+a_2}$ (B) $\frac{a_1+a_2}{2}$
(C) a_1-a_2 (D) a_1+a_2

Q24 A force of $100\ \mathrm{N}$ is applied on a block of mass $3\ \mathrm{kg}$ as shown in the figure. The coefficient of friction between the surface and the block is $\mu=\frac{1}{\sqrt{3}}$. The frictional force acting on the block is (g = 10 m s^{-2})

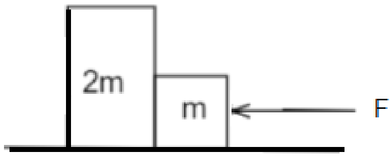


(A) $15\ \mathrm{N}$ downwards
(B) $25\ \mathrm{N}$ upwards
(C) $20\ \mathrm{N}$ downwards
(D) $30\ \mathrm{N}$ upwards

Q25 Two blocks are in contact on a frictionless table. One has mass *m* and the other \(2*m*\ \)a force *F* is applied on\(\ 2*m*\) as shown in the figure. Now the same force *F* is applied from the right on *m*. In the two cases respectively, the ratio of the force of contact between the two blocks will be



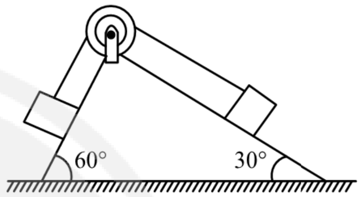
Case (i)



Case (ii)

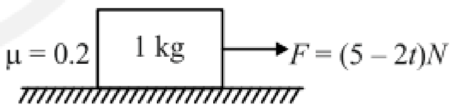
(A) 1:1 (B) $1:2$
(C) $2:1$ (D) $1:3$

Q26 Two blocks of equal mass are tied with a light string, which passes over a massless pulley as shown in figure. The magnitude of acceleration of both the blocks is (neglect friction everywhere)



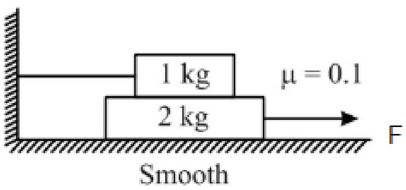
(A) $\left(\frac{\sqrt{3}-1}{4}\right)g$ (B) $(\sqrt{3}-1)g$
(C) $\frac{g}{2}$ (D) $\left(\frac{\sqrt{3}-1}{\sqrt{2}}\right)g$

Q27 The force acting on the block is given by $F=(5-2t)\ N$ as shown in the figure. The frictional force acting on the block after time $t=2$ second will be (At $t=0$, the block is stationary and $g=10ms^{-2}$)



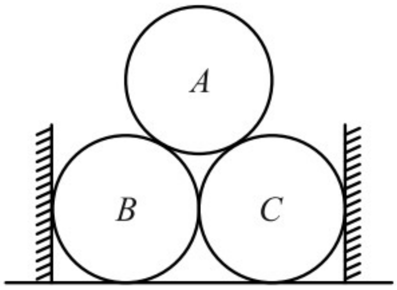
(A) $2\ \mathrm{N}$ (B) $3\ \mathrm{N}$
(C) $1\ \mathrm{N}$ (D) $Zero$

Q28 Minimum force required to pull the lower block in the given situation is (Take $g=10\ \mathrm{m/s^2}$)



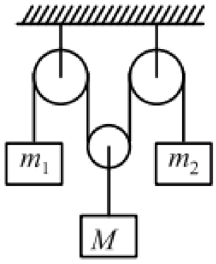
(A) $1\ \mathrm{N}$ (B) $5\ \mathrm{N}$
(C) $7\ \mathrm{N}$ (D) $10\ \mathrm{N}$

Q29 Three identical smooth cylinders each of mass $\sqrt{3}$ kg are placed as shown in the figure. Find the normal reaction between cylinder A and B.



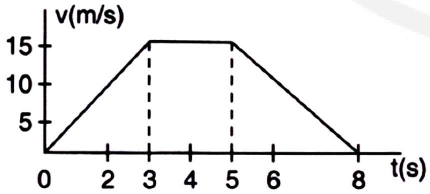
(A) 10 N (B) 20 N
(C) $10\sqrt{3}$ N (D) $5\sqrt{3}$ N

Q30 In the arrangement shown in the figure, $m_1 = 3$ kg and $m_2 = 6$ kg. If the block of mass M remains stationary, then its mass is



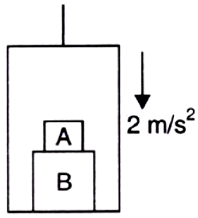
(A) 2 kg (B) 6 kg
(C) 8 kg (D) 4 kg

Q31 A particle of mass 50 g moves on a straight line. The variation of speed with time is shown in the figure. The force acting on the particle at $t = 2$, 4 and 6 seconds is:



(A) 0.25 N along the motion, zero and 0.25 N opposite to the motion.
(B) 0.25 N opposite to the motion, zero and 0.25 N along the motion.
(C) 0.25 N along the motion, zero and 0.25 N along the motion.
(D) 0.25 N opposite to the motion, zero and 0.25 N opposite to the motion.

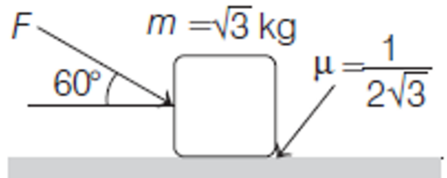
Q32 The elevator shown in the figure is descending with an acceleration of 2 m/s^2. The mass of the block A is 0.5 kg. The force exerted by the block A on the block B is:



(A) 4 N (B) 8 N
(C) 16 N (D) 20 N

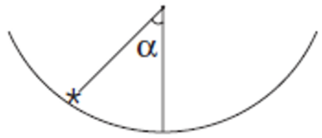
Q33 During pedalling of a bicycle, the force of friction exerted by the ground on the two wheels is such that it acts
(A) in the backward direction on the front wheel and in the forward direction on the rear wheel
(B) in the forward direction on the front wheel and in the backward direction on the rear wheel
(C) in the backward direction on both the front and the rear wheels
(D) in the forward direction on both the front and the rear wheels

Q34 What is the maximum value of the force F such that the block shown in the arrangement, does not move?



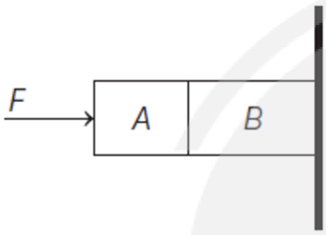
(A) 20 N (B) 10 N
(C) 12 N (D) 15 N

Q35 An insect crawls up a hemispherical surface very slowly (see the figure). The coefficient of friction between the surface and the insect is 1/3. If the line joining the centre of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is given:



(A) $\cot \alpha = 3$
(B) $\tan \alpha = 3$
(C) $\sec \alpha = 3$
(D) $\operatorname{cosec} \alpha = 3$

Q36 Given in the figure are two blocks *A* and *B* of weight 20 N and 100 N, respectively. These are being pressed against a wall by a force *F* as shown in figure. If the coefficient of friction between the blocks is 0.1 and between block *B* and the wall is 0.15, the frictional force applied by the wall on block *B* is:



(A) 100 N (B) 120 N
(C) 80 N (D) 150 N

Q37 A sports car is rounding a flat unbanked curve with radius of 230 m. The coefficient of friction between road and tyre is 0.96, the maximum speed at which driver can take the turn without sliding is nearly; ($g = 10$ m/s^2)
(A) 32 m/s (B) 42 m/s
(C) 47 m/s (D) 52 m/s

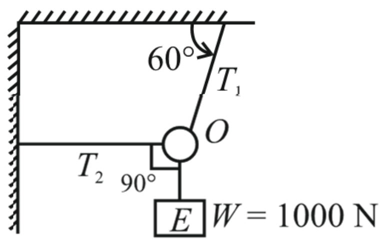
Q38 A large block of mass 40 kg is dragged horizontally along the platform of railway station with 30 kgf horizontal force. The coefficient of friction between block and concrete of platform is 0.5. The force of friction is;
(A) 30 kgf (B) 25 kgf
(C) 20 kgf (D) 40 kgf

Q39 A block is projected with a velocity of 20 m s^{-1} along a rough horizontal surface. If co-efficient of friction between the block and surface is 0.5 then the maximum distance travelled by the block before coming to rest will be $\left(\text{Take } g = 10 \text{ m/s}^2\right)$;
(A) 40 m (B) 25 m
(C) 30 m (D) 20 m

Q40 A ball is suspended by a thread from the ceiling of a tram car. The brakes are applied and the speed of the car changes from 36km h^{-1} to zero uniformly in 5 seconds. The angle by which ball deviates from the vertical is: $\left(g = 10 \text{ ms}^{-2}\right)$
(A) $\tan^{-1}\left(\frac{1}{3}\right)$ (B) $\tan^{-1}\left(\frac{1}{4}\right)$
(C) $\tan^{-1}\left(\frac{1}{5}\right)$ (D) $\tan^{-1}\left(\frac{1}{2}\right)$

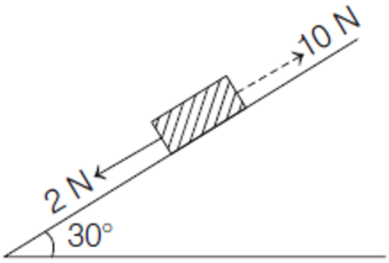
Q41 A heavy block of mass *M* hangs in equilibrium from the end of the rope of mass *m* and length ℓ which is connected to the ceiling. The tension in the rope at distance *x* from the ceiling is; (neglect size of block)
(A) $Mg + mg\left(\frac{\ell - x}{x}\right)$
(B) $Mg + mg\left(\frac{\ell - x}{\ell}\right)$
(C) $Mg + mg\left(\frac{x}{\ell}\right)$
(D) $mg + Mg\left(\frac{1 - x}{\ell}\right)$

Q42 A car engine with weight 1000 N hangs from a chain that is linked at ring *O* to two other chains, one fastened to ceiling and other to the wall as shown. The weights of chain and ring are negligible, then tension T_1 and T_2 respectively are:



(A) 1000 N, 580 N (B) 1155 N, 577 N
(C) 1200 N, 620 N (D) 1500 N, 710 N

Q43 A block kept on a rough inclined plane, as shown in the figure, remains at rest up to a maximum force 2 N down the inclined plane. The maximum external force up the inclined plane that does not move the block is 10 N. The coefficient of static friction between the block and the plane is (Take, $g = 10$ m/s^2)

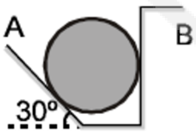


(A) $\frac{2}{3}$
(B) $\frac{\sqrt{3}}{2}$
(C) $\frac{\sqrt{3}}{4}$
(D) $\frac{1}{2}$

Q44 A boy having a mass equal to 40 kilograms is standing in an elevator. The force felt by the feet of the boy will be greatest when the elevator (g = 9.8 metre/sec^2)

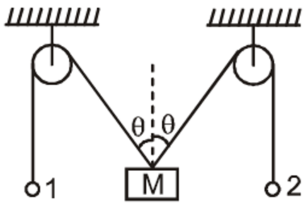
(A) Stands still
(B) Moves downwards at a constant velocity of 4 metre/sec.
(C) Accelerates downward with an acceleration equal to 4 metres/sec^2
(D) Accelerates upward with an acceleration equal to 4 metres/sec^2

Q45 The 50 kg homogeneous smooth sphere rests on the 30° incline A and bears against the smooth vertical wall B. The contact forces at A and B will be:



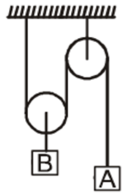
(A) $N_A = \frac{1000}{\sqrt{3}}N,\ N_B = \frac{500}{\sqrt{3}}N$
(B) $N_A = \frac{1000}{\sqrt{3}}N,\ N_B = \frac{1000}{\sqrt{3}}N$
(C) $N_A = \frac{500}{\sqrt{3}}N,\ N_B = \frac{500}{\sqrt{3}}N$
(D) $N_A = \frac{500}{\sqrt{3}}N,\ N_B = \frac{400}{\sqrt{3}}N$

Q46 Two particles 1 and 2 are hanging with two massless strings passing over fixed pulleys as shown. If they both move downward with an acceleration a, the mass M will move with acceleration



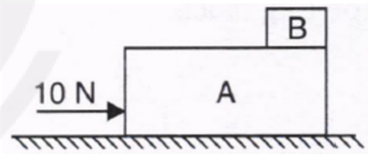
(A) $a \cos\theta$
(B) $2a \cos\theta$
(C) $a \sec\theta$
(D) $2a \sec\theta$

Q47 The ration of magnitudes of acceleration of A and B is:



(A) 2
(B) 1
(C) $\frac{1}{2}$
(D) 3

Q48 A small block B is placed on another block A of mass 5 kg and length 20 cm. Initially the block B is near the right end of block A in the figure. A constant horizontal force of l0 N is applied to the block A. All the surfaces are assumed frictionless. The time elapsed before the block B separates from A is:



(A) 0.35 s
(B) 0.45 s
(C) 0.55 s
(D) 0.65 s

Q49 Choose the **INCORRECT** statement (with respect to the 2nd law of motion)

(A) Any internal force in the system are not included in net force while writing equation.
(B) Acceleration at any point is determined by the force at that point at that instant, not by any history of the motion of the particle.
(C) In the second law, $F = 0$ implies $a = 0$. The second law is obviously consistent with the first law.
(D) If a force is not parallel to the velocity of the body, but makes some angle with it, it changes only component of velocity along

the direction perpendicular to direction of force.

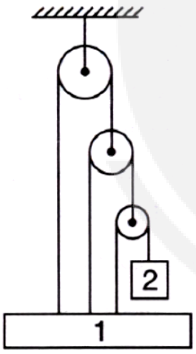
Q50 A cricket ball of mass 160 g is moving horizontally directly towards a batsman. Its speed just before it hits the bat is 30 m/s. It leaves the bat at 40 m/s at 90° to its original direction. Find the magnitude of the impulse (in N-s) imparted to the ball.

(A) 4.8 (B) 8
(C) 6.4 (D) 10

Q51 A bullet of mass 20 g has an initial speed of 1 ms^{-1}, just before it starts penetrating a mud wall of thickness 20 cm. If the wall offers a mean resistance of 2.5×10^{-2} N, the speed of the bullet after emerging from the other side of the wall is close to:

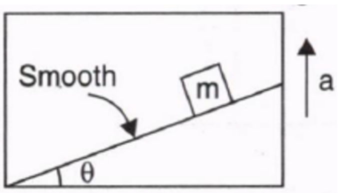
(A) 0.3 ms^{-1} (B) 0.4 ms^{-1}
(C) 0.1 ms^{-1} (D) 0.7 ms^{-1}

Q52 The relation between a_1 and a_2 is (where a_1 and a_2 are acceleration of block 1 and 2 respectively)



(A) $a_1 + 7a_2 = 0$ (B) $a_1 - 7a_2 = 0$
(C) $a_2 - 7a_1 = 0$ (D) $a_2 + 7a_1 = 0$

Q53 The acceleration of m w.r.t wedge is



(A) $(g + a)\sin\theta$
(B) $(g - a)\sin\theta$
(C) $(g + a)\cos\theta$
(D) $(g - a)\cos\theta$

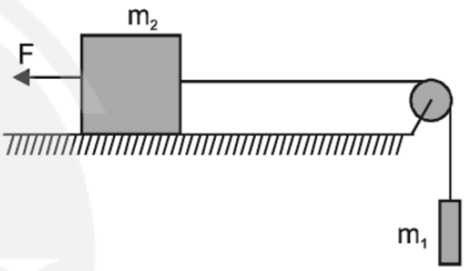
Q54 Gravels are dropped on a conveyor belt at the rate of 0.5 kg/sec. The extra force required in newtons to keep the belt moving at 2 m/sec is:

(A) 1 (B) 2
(C) 4 (D) 0.5

Q55 An object of mass 3 kg is at rest. If a force $\vec{F} = \left(6t^2\hat{i} + 4t\hat{j}\right)\mathrm{N}$ is applied on the object, then the velocity of the object at t = 3 s is:

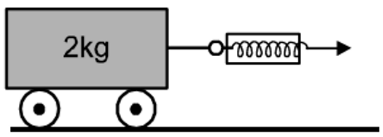
(A) $18\hat{i} + 3\hat{j}$ (B) $18\hat{i} + 6\hat{j}$
(C) $\hat{i} + 18\hat{j}$ (D) $18\hat{i} + 4\hat{j}$

Q56 A constant force $F = m_1g/2$ is applied on the block of mass m_2 as shown in figure. The string and the pulley are light and the surface of the table is smooth. Find the acceleration of m_2.



(A) $\frac{m_1 g}{2(m_1+m_2)}$ (B) $\frac{m_2 g}{2(m_1+m_2)}$
(C) $\frac{m_1}{2(m_1+m_2)}$ (D) $\frac{m_2}{2(m_1+m_2)}$

Q57 A massless spring balance is attached to 2 kg trolley and is used to pull the trolley along a flat surface as shown in the figure. The reading on the spring balance remains at 10 kg during the motion. The acceleration of the trolley is (Use g = 9.8 ms^{-2})



(A) 4.9 ms^{-2} (B) 9.8 ms^{-2}
(C) 49 ms^{-2} (D) 98 ms^{-2}

Q58 A light spring balance hangs from the hook of the other light spring balance and a block of mass M kg hangs from the former one. Then the **true** statement about the scale reading is:

(A) Both the scale read M kg each

(B) The scale of the lower one reads M kg and of the upper one zero

(C) The reading of the two scales can be anything but the sum of the reading will be M kg

(D) Both the scales read $M/2$ kg

Q59 A lift is having downwards acceleration equal to the acceleration due to gravity. A body of mass M kept on the floor of the lift is pulled horizontally by a force F when lift is accelerating downward. If the coefficient of friction is m, then the frictional resistance acting on the body is:

(A) Mg (B) μMg

(C) $2\mu Mg$ (D) zero

Q60 A circular road of radius 1000 m has banking angle 45°. Find the maximum safe speed of a car having mass 2000 kg if the coefficient of friction between tyre and road is 0.5.

(A) 172 m/s (B) 124 m/s

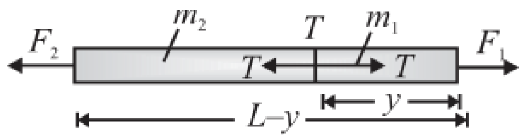
(C) 99 m/s (D) 86 m/s

Answer Key

Q1	(A)
Q2	(B)
Q3	(C)
Q4	(B)
Q5	(C)
Q6	(C)
Q7	(B)
Q8	(A)
Q9	(A)
Q10	(B)
Q11	(A)
Q12	(B)
Q13	(B)
Q14	(D)
Q15	(D)
Q16	(C)
Q17	(B)
Q18	(A)
Q19	(A)
Q20	(A)
Q21	(D)
Q22	(D)
Q23	(A)
Q24	(C)
Q25	(B)
Q26	(A)
Q27	(A)
Q28	(A)
Q29	(A)
Q30	(C)
Q31	(A)
Q32	(A)
Q33	(A)
Q34	(A)
Q35	(A)
Q36	(B)
Q37	(C)
Q38	(C)
Q39	(A)
Q40	(C)
Q41	(B)
Q42	(B)
Q43	(B)
Q44	(D)
Q45	(A)
Q46	(C)
Q47	(A)
Q48	(B)
Q49	(D)
Q50	(B)
Q51	(D)
Q52	(D)
Q53	(A)
Q54	(A)
Q55	(B)
Q56	(A)
Q57	(C)
Q58	(A)
Q59	(D)
Q60	(A)

Hints & Solutions

Q1 Text Solution:



$m_1 = \frac{M}{L}y$ and $m_2 = \frac{M}{L}(L-y)$

Since, $a = \frac{F_1 - F_2}{M}$

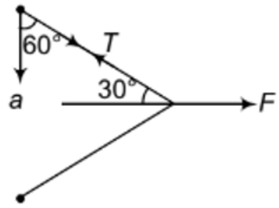
$F_1 - T = m_1 a$

$\Rightarrow T = F_1 - m_1 a = F_1 - \left(\frac{M}{L}y\right)\left(\frac{F_1-F_2}{M}\right)$

$\Rightarrow T = F_1\left(1 - \frac{y}{L}\right) + F_2\left(\frac{y}{L}\right)$

Q2 Text Solution:

$2T\cos 30° = F$



$\therefore\ T = \frac{F}{\sqrt{3}}$

$a = \frac{T\cos 60^\circ}{m}$

$= \frac{F}{2\sqrt{3}m}$

Q3 Text Solution:

$F = \left|\frac{\Delta P}{\Delta t}\right| = \left|\frac{0-mv}{\Delta t}\right| = \frac{mv}{\Delta t}$

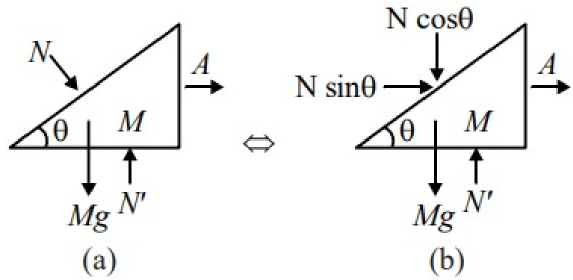
$= \frac{(120\,kg)\left(108 \times \frac{5}{18}\right)}{10} = 360\ \mathrm{N}$

Q4 Text Solution:

For wedge constraint component of acceleration along the direction perpendicular to the contact surface is same.

Let a = acceleration of rod, A = acceleration of wedge Then,

$A = a\cot\theta = 9 \times \cot 37^\circ = 12\ \mathrm{m/s^2}$



From F.B.D., $MA = N\sin\theta$

$\therefore N = \frac{MA}{\sin\theta} = \frac{10\times 12}{\frac{3}{5}} = 200\ \mathrm{N}$

Q5 Text Solution:

We can clearly see that the first two forces 1N, 2N if they are in the same direction, then they would equal to the third force 3N. But it is given in the question that the three forces are in different directions.

» So there is no possibility of equilibrium with these forces in different directions.

Q6 Text Solution:

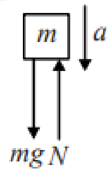
The velocity of the blocks along the string must be same.

$\Rightarrow v_1\cos\theta_1 = v_2\cos\theta_2$

$\therefore \frac{v_1}{v_2} = \frac{\cos\theta_2}{\cos\theta_1}$

Q7 Text Solution:

We shall make F.B.D., of block A.



From F.B.D., $ma = mg - N$

$\therefore N = m(g-a) = 0.5(10-2) = 4\ \mathrm{N}$

Q8 Text Solution:

By applying Newton's second law, $F_{net} = ma$

During upward motion, $T_u = m(g+a)$

During downward motion, $T_d = m(g-a)$

$\therefore T_u - T_d = 2ma = 2\times 0.1\times 5 = 1\ \mathrm{N}$

Q9 Text Solution:

The normal force between block B and floor is
$N=(8+2)g=100\ \mathrm{N}$
The maximum possible friction is
$f_{\max}=\mu N=0.5\times 100=50\ \mathrm{N}$
As the applied force $30\ \mathrm{N}$ is less than $f_{\max}$, the blocks will not move and the friction force between blocks A and B will be zero.

Q10 Text Solution:

$p=a+bt^2$

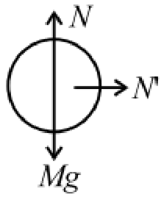
$\Rightarrow F=\frac{dp}{dt}=2bt$

$\therefore F\propto t$

Q11 Text Solution:

- A conservative force is the total work done in moving a particle between two points which is independent of the path followed. If a particle is moving in a closed loop, the total work done by a conservative force is zero.
- Here it is mandatory to note that the work done is zero if the initial and final point of the object is the same.
- Spring force, electrostatic force, gravitational force, and other examples
- Because the work done by friction depends on the path taken, it is not a conservative force.

Q12 Text Solution:



Q13 Text Solution:

$a=\frac{m_2}{m_1+m_2}\times g=\frac{5}{4+5}\times 9.8=\frac{49}{9}$

$=5.44\ \mathrm{m/s^2}$

Q14 Text Solution:

$\frac{dm}{dt}=0.1\ kg\ /\ \sec$; Mass of the rocket = 100 kg
v = 1 km/sec = 1000 m/sec

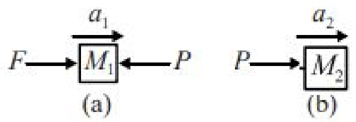
$F=\frac{d(mv)}{dt}=m\frac{dv}{dt}-v\frac{dm}{dt}=0$

(as the mass is decreasing)
$100a - 1000 \times 0.1 = 0$

$a = +1\ \mathrm{m/s^2}$

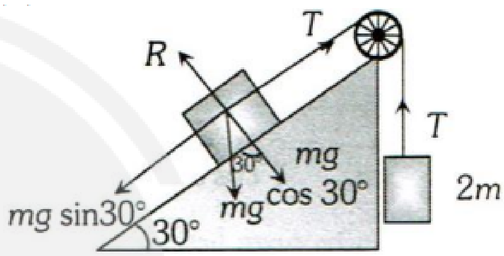
Q15 Text Solution:

The force exerted by the spring (say P) on both the block will be same.



For F.B.D., we have $M_1a_1=F-P$ and
$M_2a_2=P$
On adding these eqns, we get
$M_1a_1+M_2a_2=F$
$\therefore a_2=\frac{F-M_1a_1}{M_2}$

Q16 Text Solution:



$2mg - T = 2ma$ ...(i)
$T - mg\sin 30° = ma$ ...(ii)
(i) + (ii) gives,
$2mg-\frac{mg}{2}=3ma\Rightarrow a=\frac{g}{2}$

Q17 Text Solution:

Spring balance measures tension
Reading = Tension in spring balance = $2\ \mathrm{N}$

Q18 Text Solution:

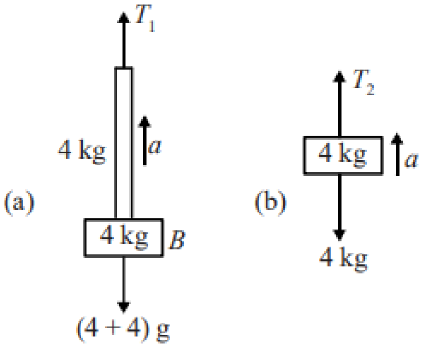
1. Impulse is a physical quantity which is equal to change in momentum (difference between final momentum and initial momentum), so basically it is a momentum only, so it will have same units as that of momentum.
2. Hence, it can be inferred that both assertion and reason are true and the given reason is the correct explanation of the given assertion.

Q19 Text Solution:

$F=\frac{d}{dt}(mv)=m\frac{dv}{dt}+v\frac{dm}{dt}=0+10\times\frac{12}{60}$
$=2\ \mathrm{N}$

Q20 Text Solution:

Let $a=$ acceleration of the system
$T_1=$ Tension in rope at A
$T_2=$ Tension in rope at B
For (rope + lower block),



$T_1-(4+4)g=(4+4)a$
$\Rightarrow T_1=8(g+a)$
For lower block,
$T_2-4g=4a$
$\Rightarrow T_2=4(g+a)$
From (1) and (2),
$\frac{T_1}{T_2}=2$

Q21 Text Solution:

$T=1\times a$ or $1.5=a$
$F=(1+2)$ kg $\times 1.5$ ms$^{-2}=4.5$ N

Q22 Text Solution:

$T_2=(m_1+m_2)\times\frac{T_3}{m_1+m_2+m_3}$
$=\frac{(10+6)\times 40}{20}=32$ N

Q23 Text Solution:

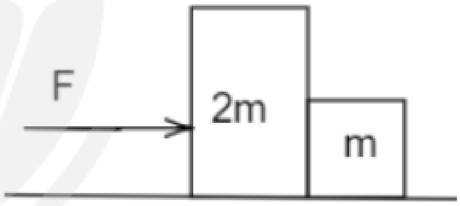
Let the required acceleration be a. Then,
$F=m_1a_1=m_2a_2=(m_1+m_2)a$
$\Rightarrow m_1=\frac{F}{a_1}, m_2=\frac{F}{a_2}$ and $m_1+m_2=\frac{F}{a}$
$\Rightarrow \frac{F}{a_1}+\frac{F}{a_2}=\frac{F}{a}$
$\therefore a=\frac{a_1a_2}{a_1+a_2}$

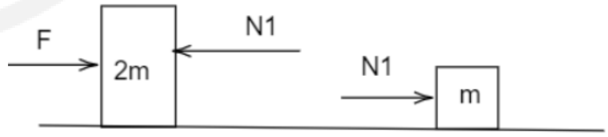
Q24 Text Solution:

$F=100\ N$
$m=3kg$
$\mu=\frac{1}{\sqrt{3}}$
$Limiting\ friction,\ f_{lim}=\mu N$
$=\mu F\cos 30^\circ$
$f_{lim}=\frac{1}{\sqrt{3}}\times 100\times\frac{\sqrt{3}}{2}=50N$
$F_{applied}=F\sin 30^\circ-mg=\ 100\times\frac{1}{2}-30$
$F_{applied}=20N$
$As\ f_{lim}>F_{applied},\ block\ doesn't\ move$
$F_{friction}=F_{applied}=20\ N$

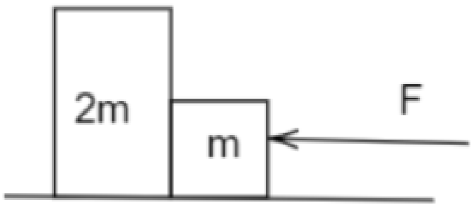
Q25 Text Solution:

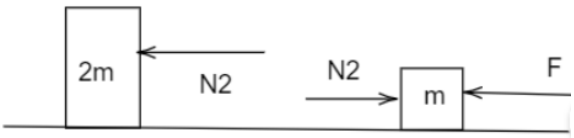
Let the force applied be F,
then net acceleration of the system will be
$a=\frac{F}{2m+m}=\frac{F}{3m}$ (considering the blocks to be one system)
When force is applied from the left ,the value of N_1 will be $=\frac{F}{3m}m=\frac{F}{3}$
where N_1 is the force of contact causing the movement of block of mass m.





When force is applied from the right,the value of N_2 will be
$=\frac{F}{3m}2m=\frac{2F}{3}$.
where N_2 is the force of contact causing the movement of the block of mass $2m$.





Hence the ratio is $1 : 2$.

Q26 Text Solution:

Acceleration of system, $a = \frac{mg\sin 60 - mg\sin 30}{2m}$

$a = \left(\frac{\sqrt{3}-1}{4}\right)g$

Q27 Text Solution:

Maximum friction,

$f_{\max}, = \mu mg = 0.2 \times 1 \times 10 = 2\text{ N}$

$\text{Initial force } = 5\text{ N} > 2\text{ N}$

So, block will move with acceleration.

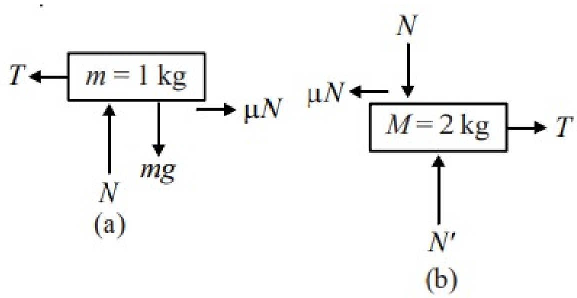
$a = \frac{F - f_{\max}}{m} = \frac{5-2t-2}{1} = 3 - 2t$

$\Rightarrow \int_0^v dv = \int_0^t \left(3 - 2t\right) dt \Rightarrow v = 3t - t^2$

The block comes to rest again at $t = 3\text{ s}$, At $t = 2\text{ s}$, the block is moving and hence, friction force acting on the block is $f_{\max} = 2\text{ N}$

Q28 Text Solution:

For minimum force, friction between blocks is μN and acceleration is zero.



From F.B.D.,

$N = mg \text{ and } F = \mu N$

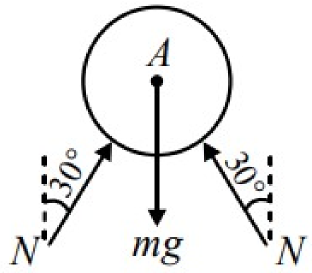
$\therefore F = \mu mg = 0.1 \times 1 \times 10 = 1\text{ N}$

Q29 Text Solution:

From FBD of A,

$2N\cos 30^\circ = mg$

$\therefore N = \frac{mg}{\sqrt{3}} = \sqrt{3} \times \frac{10}{\sqrt{3}} = 10\text{ N}$

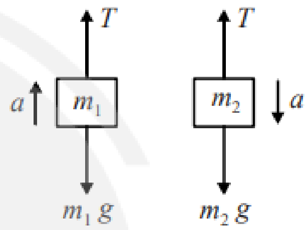


Q30 Text Solution:

If the tension is string is T, then

$2T = Mg$

$\Rightarrow T = \frac{Mg}{2}$



Since M is stationary, the magnitude of acceleration of m_1 and m_2 is same.

From FBD,

$m_1 a = T - m_1 g \text{ and } m_2 a = m_2 g - T$

$\Rightarrow T = \frac{2m_1 m_2}{m_1 + m_2} g = \frac{2\times3\times6}{3+6} g = 4g$

$\Rightarrow \frac{Mg}{2} = 4g$

$\therefore M = 8\text{ kg}$

Q31 Text Solution:

At $t = 2$s, velocity is increasing, so acceleration is positive.

$F = ma = 0.05 \times 5 = 0.25$ N along motion.

At $t = 4$s, velocity is constant, so acceleration and force are zero.

At $t = 6$s, velocity is decreasing, so acceleration is negative.

$F = 0.25$ N opposite to motion.

Q32 Text Solution:

Elevator accelerates down: effective gravity $= g' = g - a = 10 - 2 = 8\text{ m/s}^2$

Force by A on B = weight of A in elevator

$= F = m \times g' = 0.5 \times 8 = 4N$

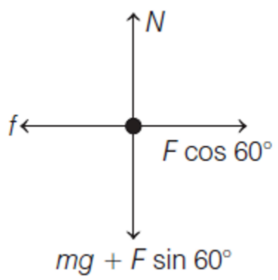
Q33 Text Solution:

Rear wheel: Pedalling tries to push the contact point backward, so friction acts forward to move the cycle ahead.

Front wheel: No driving torque, so as the cycle moves, friction acts backward to make the wheel rotate properly.

So, rear wheel friction is forward, front wheel friction is backward.

Q34 Text Solution:



For vertical equilibrium of the block

$N = mg + F \sin 60^\circ$

$= \sqrt{3}g + \sqrt{3}\frac{F}{2}$ ....(i)

For no motion, force of friction

$f \geq F \cos 60^\circ$

or $\mu N \geq F \cos 60^\circ$

or $\frac{1}{2\sqrt{3}}\left(\sqrt{3}g + \frac{\sqrt{3}}{2}F\right) \geq \frac{F}{2}$

or $g \geq \frac{F}{2}$ or $F \leq 2g$ or $20\ \mathrm{N}$

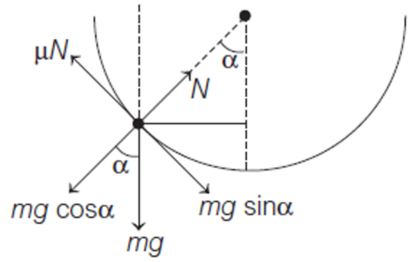
Therefore, maximum value of F is 20 N.

Q35 Text Solution:

Equilibrium of insect gives

$\mu N = mg \sin \alpha$

$N = mg \cos \alpha$ ...(i)



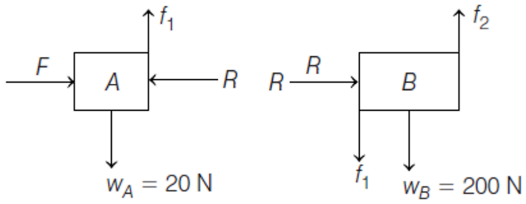
From Eqs. (i) and (ii), we get

$\cot \alpha = \frac{1}{\mu} = 3$

Beyond angle of repose insect will slip.

Q36 Text Solution:

The free body diagram of two blocks is as shown below,



Reaction force, R = applied force F

For vertical equilibrium of A;

f_1 = friction between two blocks = W_A = 20 N

For vertical equilibrium of B;

f_2 = friction between block B and wall

$= W_B + f_1 = 100 + 20 = 120$ N

Q37 Text Solution:

$f_{\max} = \mu_s N$

$\frac{m\nu_{\max}^2}{r} = \mu_s \times N$ and $N = mg$

$\nu_{\max} = \sqrt{\mu_s \times g \times R}$

$= \sqrt{0.96 \times 10 \times 230} = 47\ \mathrm{m/s}$

Q38 Text Solution:

$F_{\max} = 0.5 \times 40 \times g = 20\ \mathrm{kgf}$

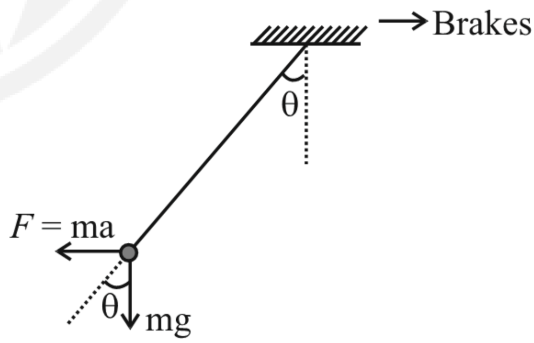
Q39 Text Solution:

$\frac{1}{2}m \times (20)^2 = 0.5 \times m \times g \times x$

$200 = 0.5 \times 10 \times x$

$x = \frac{200}{5} = 40\ \mathrm{m}$

Q40 Text Solution:



$\tan \theta = \frac{a}{g}$

$a = \frac{\Delta V}{\Delta t} = \frac{0-10}{5} = -2\ \mathrm{m/s^2}$

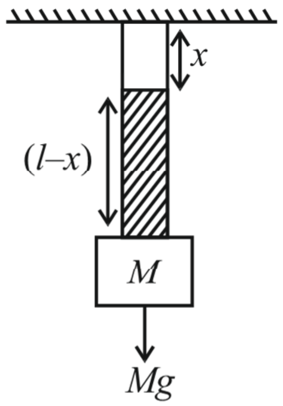
$g = 10\ \mathrm{m/s^2}$

$\tan \theta = \frac{1}{5}$

$\theta = \tan^{-1}\left(\frac{1}{5}\right)$

Q41 Text Solution:

Drawing FBD at distance x from top



Mass of rope = m

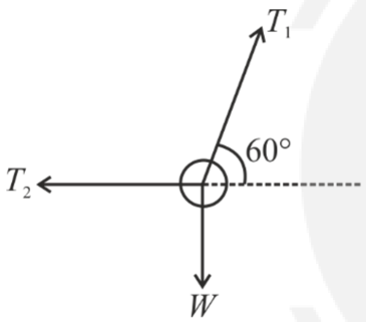
Mass per unit length of rope = $\frac{m}{l}$

Tension in rope at distance x from ceiling will be equal to weight of heavy block plus weight of rope of length ($l - x$)

$$T = g\left[M + m\left(1 - \frac{x}{l}\right)\right]$$

Q42 Text Solution:

By Lami's theorem



$$\frac{T_1}{\sin 90^\circ} = \frac{T_2}{\sin(150^\circ)} = \frac{W}{\sin 120^\circ}$$

$$\frac{T_1}{\sin 90^\circ} = \frac{T_2}{\sin 30^\circ} = \frac{1000}{\sin 60^\circ}$$

$$T_1 = \frac{1000}{\sin 60^\circ} \times \sin 90^\circ = \frac{1000\times 2}{\sqrt{3}} = 1155 \text{ N}$$

$$T_2 = \frac{1000}{\sin 60^\circ} \times \sin 30^\circ = \frac{1000}{\sqrt{3}} = 577 \text{ N}$$

Q43 Text Solution:

case-1:

$N = mg\cos\theta$ and $f = \mu N$

or $2 + mg\sin\theta = \mu\, mg\cos\theta$ ...(i)

case-2:

$mg\sin\theta + f = 10$ N

Here, $f = \mu N = \mu\, mg\cos\theta$

or $mg\sin\theta + \mu\, mg\cos\theta = 10$ ...(ii)

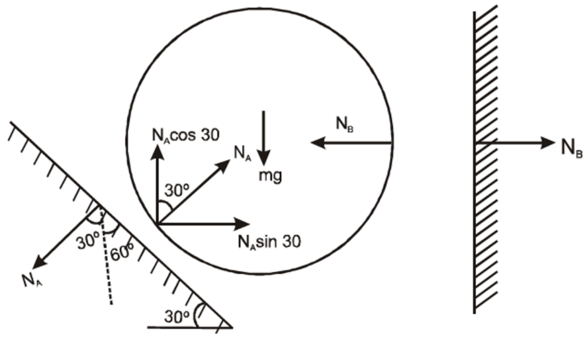
Now, solving Eqs. (i) and (ii), we get

$$\mu = \frac{\sqrt{3}}{2}$$

Q44 Text Solution:

When acclerated upward $N - mg = ma \Rightarrow N = m(g + a)$

Q45 Text Solution:



$mg - N_A\cos 30^\circ = 0$ [Equilibrium in vertical direction]

$$\Rightarrow N_A = \frac{mg}{\cos 30^\circ}$$

$$\Rightarrow N_A = \frac{1000}{\sqrt{3}} N$$

$N_B - N_A\sin 30^\circ = 0$ [Equilibrium in horizontal]

$$\Rightarrow N_B = N_A\sin 30^\circ$$

$$\Rightarrow N_B = \frac{1000}{\sqrt{3}}\frac{1}{2}$$

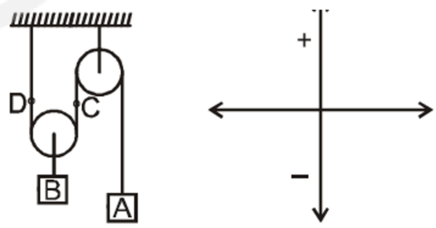
$$\Rightarrow N_B = \frac{500}{\sqrt{3}} N$$

Q46 Text Solution:

In fact, if the free ends of the rope (points 1 and 2) both move downward with acceleration a, the mass moves upward with acceleration.

$$a_M = \frac{a}{\cos\theta} = a\sec\theta$$

Q47 Text Solution:



using the above coordinate system, we have

$a_A + a_C = 0$ (as pulley is fixed)

$a_C + a_D = 2a_B$

$a_C = 2a_B$ (as D is fixed)

So, $-a_A = 2a_B$

Hence Magnitude of $a_A = 2a_B$

Q48 Text Solution:

$$a = \frac{F}{m} = \frac{10}{5} = 2 \text{ m/s}^2$$

Block A must move right by the full length of the top surface (0.20 m) before B which stays fixed in the lab frame reaches A's left edge:
s = 0.20 m
With $s = \frac{1}{2}at^2$,
$t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2\times0.20}{2}}$
$= \sqrt{0.20} \approx 0.45\,\text{s}.$

Q49 Text Solution:

A force $\vec{F}$ can only change the component of velocity along its own direction (i.e. parallel to $\vec{F}$); it leaves the component perpendicular to $\vec{F}$ unchanged.
Hence statement 4 is the incorrect one.

Q50 Text Solution:

Mass m = 0.160 kg
Initial velocity: $\vec{v}_i = \left(30\hat{i}\right)\,\text{m/s}$
Final velocity: $\vec{v}_f = \left(40\hat{j}\right)\,\text{m/s}$
Impulse magnitude:
$\left|\Delta\vec{p}\right| = \left|m\vec{v}_f - m\vec{v}_i\right|$
$= m\sqrt{v_i^2 + v_f^2}$
$= 0.16\sqrt{30^2 + 40^2}$
$= 0.16 \times 50 = 8\,\text{Ns}$

Q51 Text Solution:

Given, resitance offered by the wall
$F = -2.5 \times 10^{-2}N$
So, deceleration of bullet,
$a = \frac{F}{m} = \frac{-2.5\times10^{-2}}{20\times10^{-3}} = -\frac{5}{4}ms^{-2}$
$(\because m = 20g = 20 \times 10^{-3}kg)$
Now, using the equation of motion,
$v^2 - u^2 = 2as$
We have,
$v^2 = 1 + 2\left(-\frac{5}{4}\right)\left(20 \times 10^{-2}\right)$
$(\because\ u = 1ms^{-1}s = 20cm = 20 \times 10^{-2}m)$
$\Rightarrow\ v^2 = \frac{1}{2}$
$\therefore\ v = \frac{1}{\sqrt{2}} \approx 0.7\,\text{ms}^{-1}$

Q52 Text Solution:

From constraint relation,
$T \propto \frac{1}{a}$
Tension on block 2 = T
Tension on block 1 = 7 T
So, $a_2 = -7a_1$ (Due to opposite direction)
or $a_2 + 7a_1 = 0$

Q53 Text Solution:

In the non-inertial frame of the wedge (which accelerates upward at a), the block feels an extra "pseudo-gravity" ma downward in addition to its weight mg. Hence the effective gravity in the wedge-frame is
$g_{\text{eff}} = g + a$.
The component of this along the plane (downhill) is
$a_{\text{rel}} = g_{eff}\sin\theta$
$= (g + a)\sin\theta$
So, the acceleration of m relative to the wedge is $(g + a)\sin\theta$.

Q54 Text Solution:

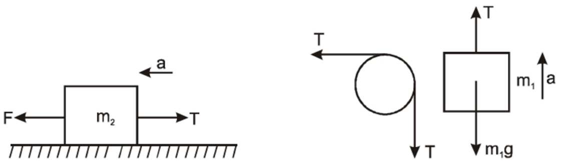
Opposing force F = $u\left(\frac{dm}{dt}\right) = 2 \times 0.5 = 1\,\text{N}$
$\left(\text{As},\ F = u\frac{du}{dt}\right)$
So same amount of force is required to keep the belt moving at 2 m/s.

Q55 Text Solution:

$\vec{F} = \frac{d\vec{p}}{dt}$
$\vec{F} = m\frac{d\vec{v}}{dt}\ \ \ldots\ldots\ (\text{i})$
Substituting we get, 1
$F = \left(6t^2\hat{i} + 4t\hat{j}\right) = 3\frac{d\vec{v}}{dt}$
or $d\vec{v} = \frac{1}{3}\left(6t^2\hat{i} + 4t\hat{j}\right)dt$
Now, taking integration of both sides, we get
$\int d\vec{v} = \int_0^t \frac{1}{3}\left(6t^2\hat{i} + 4t\hat{j}\right)dt$
$\therefore\ \ \vec{v} = \frac{1}{3}\int_0^3\left(6t^2\hat{i} + 4t\hat{j}\right)dt$
$\vec{v} = \frac{1}{3}\left[\frac{6t^3}{3}\hat{i} + \frac{4t^2}{2}\hat{j}\right]_0^3$
$v = \frac{1}{3}\left[2\left(3\right)^3\hat{i} + 2\left(3\right)^2\hat{j}\right]$
$\vec{v} = \frac{1}{3}\left[54\hat{i} + 18\hat{j}\right]$

$\vec{v} = 18\hat{i} + 6\hat{j}$

Q56 Text Solution:



It is obvious that acceleration of both the blocks is same in magnitude.

$F - T = m_2 a$ [Newton's second law on m_2]

$T - m_1 g = m_1 a$ [Newton's second law on m_1]

After adding the above equations.

$F - m_1 g = (m_2 + m_1) a$

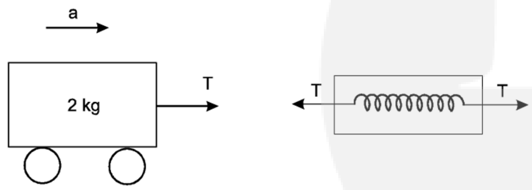
$\frac{m_1 g}{2} - m_1 g = (m_2 + m_1) a$

$\Rightarrow a = -\frac{m_1 g}{2(m_1 + m_2)}$

The value of a is –ve it means

$a = \frac{m_1 g}{2(m_1 + m_2)}$ in the direction opposite to assumed direction.

Q57 Text Solution:



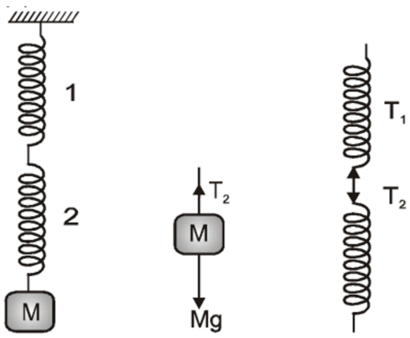
Reading of spring balance is same as tension in the balance.

$\Rightarrow T = 10\,\mathrm{g} = 98\mathrm{N}$

$T = 2\,a$ [Newton's II law for 2 kg block]

$\Rightarrow \quad a = 49\ \mathrm{m/s^2}$

Q58 Text Solution:



Since springs are massless.

$T_1 = T_2 = Mg.$

Q59 Text Solution:

$N = 0$, so friction = 0

Q60 Text Solution:

Using the formula for a banked curve with friction,

$v^2 = rg\frac{\sin\theta + \mu\cos\theta}{\cos\theta - \mu\sin\theta},$

with $r = 1000$ m, $g = 9.8\ \mathrm{m/s^2}$, $\theta = 45^\circ$,

$\mu = 0.5$ gives

$v \approx 172\,\mathrm{m/s}.$