PHYSICS

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NEWTON'S LAWS OF MOTION

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NEWTON'S LAWS OF MOTION

DPP-1 (JPP/019)

[Newton's First Law of Motion, Inertia and Mass, Momentum, Mathematical Formulation of Second Law]

1. When a train stops suddenly, passengers in the train feel an instant jerk in the forward direction because

(A) The back of seat suddenly pushes the passengers forward

(B) Inertia of rest stops the train and takes the body of passengers forward

(C) Upper part of the body continues to be in the state of motion whereas the lower part of the body in contact with seat remains at rest

(D) Nothing can be said due to insufficient data

2. A man getting down a running bus falls forward because

(A) Due to inertia of rest, road is left behind and man goes forward

(B) Due to inertia of motion, upper part of body continues to be in motion in forward direction while feet come to rest as soon as they touch the road

(C) He leans forward as a matter of habit

(D) Of the combined effect of all the three factors stated in (A), (B) and (C)

3. A boy sitting on the topmost berth in the compartment of a train which is just going to stop on a railway station, drops an apple aiming at the open hand of his brother sitting vertically below his hands at a distance of about 2 meter. The apple will fall

(A) Precisely on the hand of his brother

(B) Slightly away from the hand of his brother in the direction of motion of the train

(C) Slightly away from the hand of his brother in the direction opposite to the direction of motion of the train

(D) None of the above

4. There are two bodies A & B of same mass. Body A is at rest while body B is undergoing uniform motion, which is correct statements?

(A) Inertia of A > inertia of B.

(B) Inertia of B > inertia of A.

(C) Inertia of A = inertia of B.

(D) Either A, B or C depending upon the shape of body.

5. When an object is at rest
(A) Force is required to keep it in rest state
(B) No force is acting on it
(C) A large number of forces may be acting on it which balance each other
(D) It is in vacuum

6. If the force of gravity suddenly disappears:
(A) The mass of all bodies will become zero
(B) The weight of all bodies will become zero
(C) Both mass and weight of all bodies will become zero
(D) Neither mass nor weight of all bodies will become zero

7. A rider on horse back falls when horse starts running all of a sudden because
(A) Rider is taken back
(B) Rider is suddenly afraid of falling
(C) Inertia of rest keeps the upper part of body at rest whereas lower part of the body moves forward with the horse
(D) None of the above

8. A block of metal weighing 5 kg is resting on a frictionless plane. It is struck by a jet releasing water at a rate of 2 kg/ sec and at a speed of 4 m/s. The initial acceleration of the block will be:
(A) 1.6 m/s²
(B) 20 m/s²
(C) 2.5 m/s²
(D) None of the above

9. An object of mass 10 kg is moving at a constant velocity of 10 m/s. A constant force then acts for 4 seconds on the object and gives it a speed of 2m/s in opposite direction. The force acting on in it, is
(A) 10 N (B) 30 N
(C) 20 N (D) 40 N

10. A particle of mass 'm' originally at rest, is subjected to a force whose direction is constant but whose magnitude varies according to the relation $F = F_0 t\left[\frac{2}{T} - \frac{t}{T^2}\right]$, where F_0 and T are constant. Then speed of the particle after a time $2T$ is:
(A) $\frac{3F_0}{4m}T$ (B) $\frac{4F_0}{3m}T$
(C) $\frac{2F_0}{m}T$ (D) $\frac{F_0}{m}T$

11. A force of 10 N is applied to a mass of 10 gm for 10 seconds. The change of momentum in kgm / sec units will be________.

12. **Assertion:** Newton's first law is contained in Newton's second law.
Reason: Action and reaction act on the same body.
(A) Both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
(B) Both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
(C) Assertion is True but the Reason is False.
(D) Both Assertion & Reason are False.

DPP-2 (JPP/020)

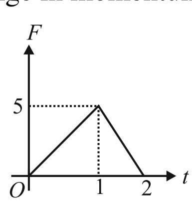
[Impulse, Application of Newton's Second Law of Motion, Applications of Third Law, Conservation of Linear Momentum]

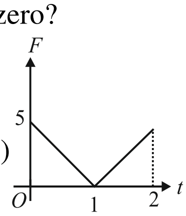
1. A jet engine works on the principle of
(A) Conservation of mass
(B) Conservation of energy
(C) Conservation of linear momentum
(D) Conservation of angular momentum

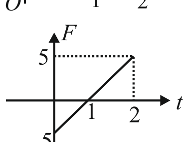
2. If n balls hit elastically and normally on a surface per unit time and all balls of mass m are moving with same velocity u, then force on surface is
(A) mun (B) $2\ mun$
(C) $\frac{1}{2}mu^2n$ (D) mu^2n

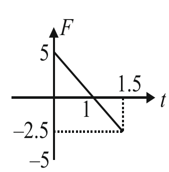
3. A ball of mass 50 g is dropped from a height of 20 m. A boy on the ground hits the ball vertically upward with a bat with an average force of 200 N, so that it attains a vertical height of 45 m. The time for which the ball remains in contact with the bat is [Take $g = 10\ m/s^2$]
(A) $1/20^{th}$ of a second
(B) $1/40^{th}$ of a second
(C) $1/80^{th}$ of a second
(D) $1/120^{th}$ of a second

4. In which of the following graphs, the total change in momentum is zero?

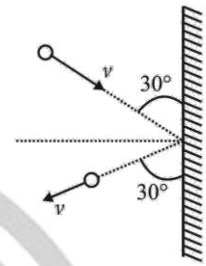
(A) 

(B) 

(C) 

(D) 

5. A particle of mass m strikes a wall with speed v at an angle 30° with the wall elastically as shown in the figure. The magnitude of impulse imparted to the ball by the wall is



(A) mv (B) $mv/2$
(C) $2\ mv$ (D) $\sqrt{3}\ mv$

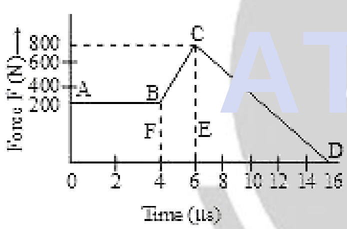
6. A force of $(6\hat{i} + 8\hat{j})$ N acted on a body of mass 10 kg. The displacement after 10 sec, if it starts from rest, will be –
(A) 50 m along $\tan^{-1} 4/3$ with x axis
(B) 70 m along $\tan^{-1} 3/4$ with x axis
(C) 10 m along $\tan^{-1} 4/3$ with x axis
(D) None

7. A body of mass M at rest explodes into three pieces, two of which of mass $M/4$ each are thrown off in perpendicular directions with velocities of 3 m/s and $4m/s$ respectively. The third piece will be thrown off with a velocity of
(A) $1.5\ m/s$
(B) $2.0\ m/s$
(C) $2.5\ m/s$
(D) $3.0\ m/s$

8. A bullet is fired from a gun. The force on the bullet is given by $F = 600 - 2 \times 10^5\, t$, where F is in newton and t in seconds. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?

(A) 9 Ns (B) Zero
(C) 0.9 Ns (D) 1.8 Ns

9. The magnitude of the force (in newton) acting on a body varies with time t (in microseconds) as shown in fig. AB, BC, and CD are straight line segments. The magnitude of the total impulse of the force on the body from $t = 4$ μs to $t = 16$ μs is



(A) 5×10^{-4} N.s
(B) 5×10^{-3} N.s
(C) 5×10^{-5} N.s
(D) 5×10^{-2} N.s

10. A 100 g iron ball having velocity 10 m/s collides at an angle 30° with a wall and rebounds at the same angle. If the period of contact between the ball and wall is 0.1 second, then the force experienced by the wall is ____________ N.

11. A player caught a cricket ball of mass 150 gm moving at a rate of 20 m/s. If the catching process is completed in 0.1 s, then the force of the blow exerted by the ball on the hands of the player is

(A) 10 N
(B) 20 N
(C) 30 N
(D) 40 N

12. **Assertion:** Aeroplanes always fly at low altitudes.
Reason: According to Newton's third law of motion, for every action there is an equal and opposite reaction.

(A) Both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
(B) Both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
(C) Assertion is True but the Reason is False.
(D) Both Assertion & Reason are False.

DPP-3

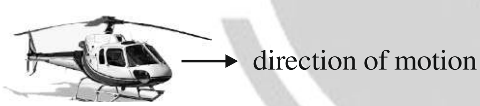
(JPP/021)

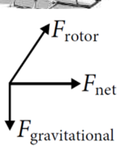
[Laws of Motion Applied to Systems, Free Body Diagram]

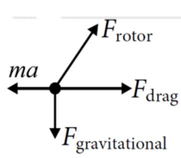
1. A bullet of mass 40 g is fired from a gun of mass 10 kg. If velocity of bullet is 400 m/s, then the recoil velocity of the gun will be

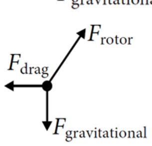
(A) 1.6 m/s in the direction of bullet
(B) 1.6 m/s opposite to the direction of bullet
(C) 1.8 m/s in the direction of bullet
(D) 1.8 m/s opposite to the direction of bullet

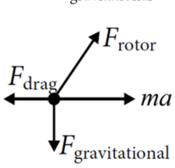
2. A helicopter is moving to the right at a constant horizontal velocity. It experiences three forces $\vec{F}_{\text{gravitational}}$, $\vec{F}_{\text{drag}}$ and force on it caused by rotor $\vec{F}_{\text{rotor}}$. Which of the following diagrams can be correct free body diagram representing forces on the helicopter?



(A)


(B)


(C)


(D)


3. Consider the three cases given in figures shown. Assume the friction to be absent everywhere and the pulleys to be light; the string connecting the blocks to other block or fixed vertical wall to be light and inextensible. Let T_A, T_B and T_C be the tension in the strings in figure A, figure B and figure C respectively. Then pick the correct comparison between the given tensions (for the instant shown) from options below.

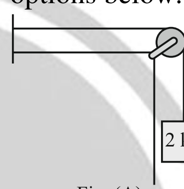


Fig. (A)

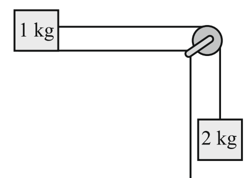


Fig. (B)

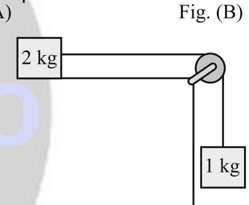
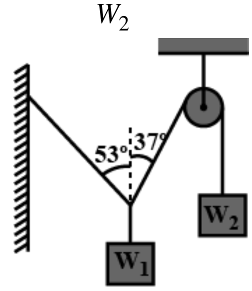


Fig. (C)

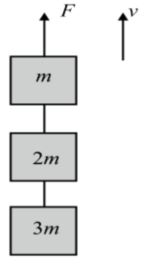
(A) $T_A = T_B = T_C$ (B) $T_B = T_C < T_A$
(C) $T_A < T_B < T_C$ (D) $T_B < T_C < T_A$

4. Two weights W_1 and W_2 in equilibrium and at rest are suspended as shown in figure. Then the ratio $\frac{W_1}{W_2}$ is:



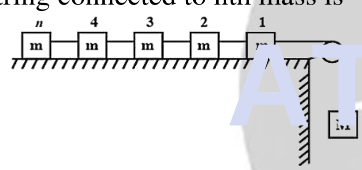
(A) 5/4
(B) 4/5
(C) 8/5
(D) none of the these

5. Three blocks with masses m, 2m and 3m are connected by strings, as shown in the figure. After an upward force F is applied on block m, the masses moves upward at constant speed v. What is the net force on the block of mass 2m?
(g is the acceleration due to gravity)



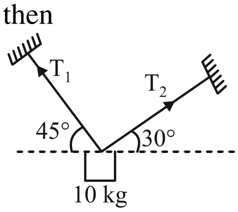
(A) 6 mg
(B) zero
(C) 2 mg
(D) 3 mg

6. In the given arrangement, n number of equal masses are connected by strings of negligible masses. The tension in the string connected to nth mass is



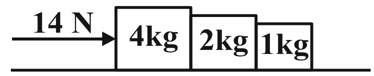
(A) $\dfrac{mMg}{nm+M}$
(B) $\dfrac{mMg}{nmM}$
(C) mg
(D) $\dfrac{mMg}{m+nM}$

7. A body of mass 10 kg is suspended by two massless strings making angles 45° and 30° with horizontal as shown in the figure, then



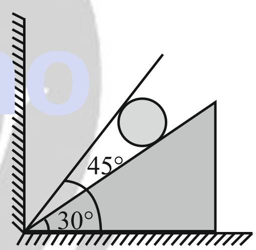
(A) $\sqrt{2}T_1 + 3T_2 = 0$
(B) $2T_1 - \sqrt{3}T_2 = 0$
(C) $\sqrt{2}T_1 - 3T_2 = 0$
(D) $\sqrt{2}T_1 - \sqrt{3}T_2 = 0$

8. Three blocks of masses 4 kg, 2 kg and 1 kg respectively are in contact on a frictionless table as shown in the figure. If a force of 14 N is applied on the 4 kg block, the contact force between the 4 kg and the 2 kg block will be



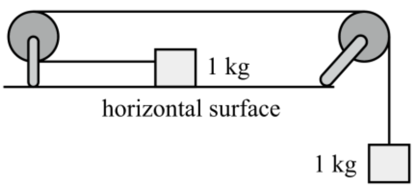
(A) 2 N
(B) 6 N
(C) 8 N
(D) 14 N

9. A spherical ball of mass m = 5 kg rests between two planes which make angles of 30° and 45° respectively with the horizontal. The system is in equilibrium. Find the normal forces exerted on the ball by each of the planes. The planes are smooth.

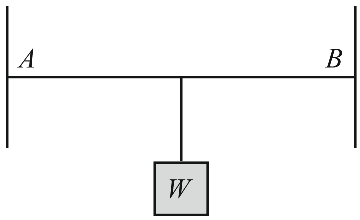


(A) N_{45} = 96.59 N, N_{30} = 136.6 N
(B) N_{30} = 96.59 N, N_{45} = 136.6 N
(C) N_{45} = 136.6 N, N_{30} = 96.56 N
(D) None of these

10. Consider the system as shown in the figure.
The pulley and the string are light, and all the surfaces are frictionless. The tension in the string is ______N. (g = 10 m/s^2)

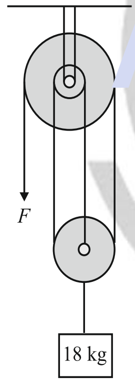


11. Find the tension in the string AB loaded with weight W at the middle, when AB is horizontal:



(A) zero (B) W
(C) $W/2$ (D) infinity

12. In the figure, at the free end of the light string, a force F is applied to keep the suspended mass of 18 kg at rest. Then the force exerted by the ceiling on the system (assume that the string segments are vertical and the pulleys are light and smooth) is ($g = 10\ \text{m/s}^2$)



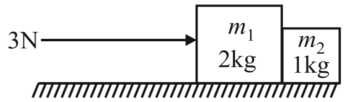
(A) 180 N (B) 360 N
(C) 120 N (D) 240 N

DPP-4

(JPP/022)

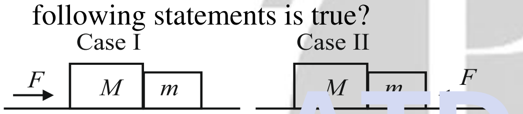
[Laws of Motion Applied to Systems, Free Body Diagram]

1. Force of 3N acts on a system of two blocks of mass 2 kg and 1 kg as shown in figure. Contact force between the blocks is:



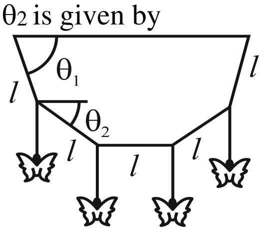
(A) 1 N (B) 2 N
(C) 3 N (D) 0

2. As shown below, two blocks with masses m and M ($M > m$) are pushed by a force F in both case I and Case II. The surface on which blocks lie, is horizontal and frictionless. Let R_I be the force that m exerts on M in case I and R_{II} be the force that m exerts on M in case II. Which of the following statements is true?



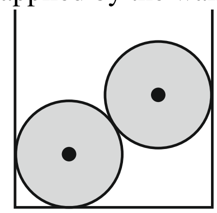
(A) $R_I = R_{II}$ and is not equal to zero or F
(B) $R_I = R_{II} = F$
(C) $R_I < R_{II}$
(D) $R_I > R_{II}$

3. Four identical metal butterflies are hanging from a light string of length $5l$ at equally placed points as shown. The ends of the string are attached to a horizontal fixed support. The middle section of the string is horizontal. The relation between the angle θ_1 and θ_2 is given by



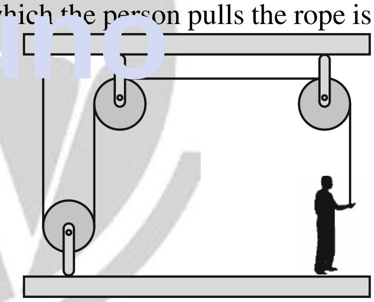
(A) $\sin\theta_1 = 2\sin\theta_2$
(B) $2\cos\theta_1 = \sin\theta_2$
(C) $\tan\theta_1 = 2\tan\theta_2$
(D) $\theta_2 < \theta_1$ and no other conclusion can be derived

4. Two smooth spheres each of radius 5 cm and weight W rest one on the other inside a fixed smooth cylinder of radius 8 cm. The reactions between the spheres and the reaction applied by the wall on spheres is:

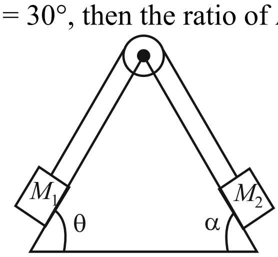


(A) $W/4$ and $3W/4$ (B) $W/4$ and $W/4$
(C) $5W/4$ and $3W/4$ (D) W and W

5. A 50 kg person stands on a 25 kg platform. He pulls on the rope which is attached to the platform via the frictionless pulleys as shown in the figure. The platform moves upward at a steady rate if the force with which the person pulls the rope is ______ N.

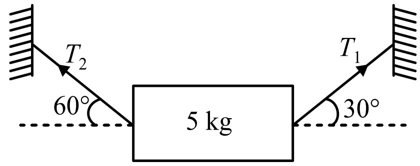


6. Two masses M_1 to M_2 connected by means of a string which is made to pass over light, smooth pulley are in equilibrium on a fixed smooth wedge as shown in figure. If $\theta = 60°$ and $\alpha = 30°$, then the ratio of M_1 to M_2 is



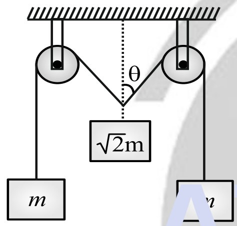
(A) $1 : 2$ (B) $2 : \sqrt{3}$
(C) $1 : \sqrt{3}$ (D) $\sqrt{3} : 1$

7. A body of mass 5 kg is suspended by the strings making angles 60° and 30° with the horizontal –



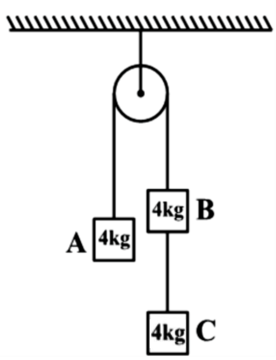
(a) $T_1 = 25$ N (b) $T_2 = 25$ N
(c) $T_1 = 25\sqrt{3}$ N (d) $T_2 = 25\sqrt{3}$ N
(A) a, b (B) a, d
(C) c, d (D) b, c

8. The pulleys and string shown in the figure are smooth and are of negligible mass. For the system to remain in equilibrium, the angle θ should be



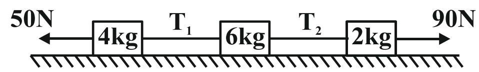
(A) 0° (B) 30°
(C) 45° (D) 60°

9. Three identical masses each of mass 4 kg are connected by massless inextensible strings. The string joining *A* and *B* passes over a massless frictionless pulley as shown in figure. The tension in the string connecting mass *B* and *C* is



(A) 40 N (B) 20 N
(C) 16 N (D) 32 N

10. In the figure shown, surface is frictionless. Forces are applied as shown in figure, then find tension T_2.



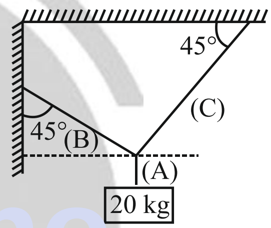
(A) $\frac{250}{3}$ N

(B) $\frac{190}{3}$ N

(C) 90 N

(D) 50 N

11. In the given diagram, the tension in string C is:



(A) 100 N (B) 70.7 N
(C) 141 N (D) 200 N

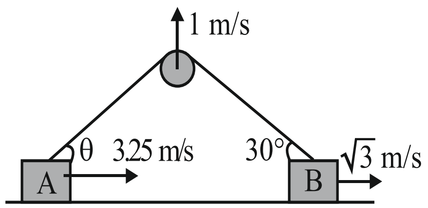
12. **Assertion:** A body can be at rest even when it is under the action of any number of external forces.
Reason: Vector sum of all the external forces on a body may be zero.
(A) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
(B) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
(C) If Assertion is True but the Reason is False.
(D) If Assertion is False but Reason is True.

DPP-5

(JPP/023)

[Problems Involving Constraint Relation]

1. In the figure shown, find out the value of θ [assume string to be tight]



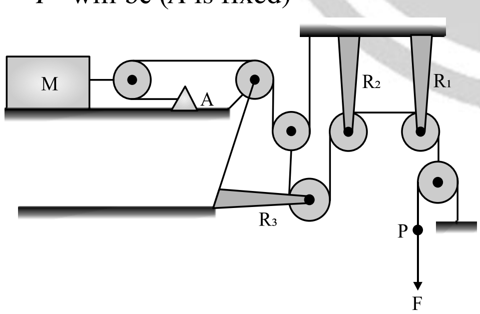
(A) $\tan^{-1}\frac{3}{4}$

(B) $\tan^{-1}\frac{4}{3}$

(C) $\tan^{-1}\frac{3}{8}$

(D) None of these

2. In the given arrangement, mass of the block is M and the surface on which the block is placed is smooth. Assuming all pulleys to be massless and frictionless, strings to be inelastic and light, R_1, R_2 and R_3 to be light supporting rods, then acceleration of point 'P' will be (A is fixed)



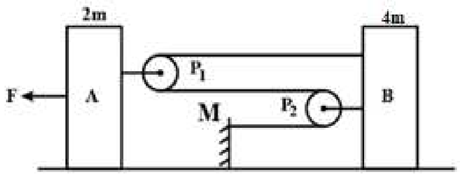
(A) 0

(B) ∞

(C) $\frac{4F}{M}$

(D) $\frac{2F}{M}$

3. Calculate the acceleration of the block B in the shown figure, assuming the surfaces and the pulleys P_1 and P_2 are all smooth and pulleys and string and light.



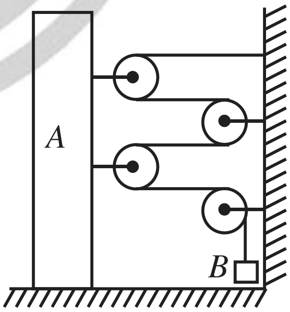
(A) $a = \frac{3F}{20m}$ m/s^2

(B) $a = \frac{3F}{21m}$ m/s^2

(C) $a = \frac{2F}{21m}$ m/s^2

(D) $a = \frac{3F}{1[illegible]m}$ m/s^2

4. Block A is moving away from the wall at a speed v and acceleration a.



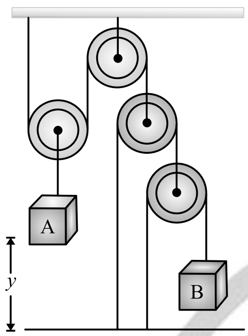
(A) Velocity of B is v with respect to A.

(B) Acceleration of B is a with respect to A.

(C) Acceleration of B is $4a$ with respect to A.

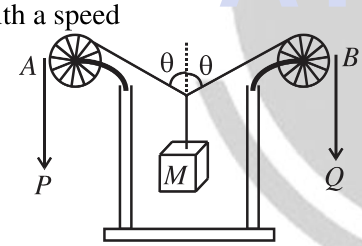
(D) Acceleration of B is $\sqrt{17}a$ with respect to A.

5. The vertical displacement of block A in meter is given by $y = \frac{t^2}{4}$ where t is in second. Calculate the downward acceleration a_B of block B.



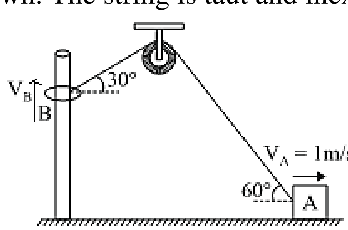
(A) 2 m/s^2 (B) 1 m/s^2
(C) 4 m/s^2 (D) 9 m/s^2

6. In the arrangement shown in figure the ends P and Q of an unstretchable string move downwards with uniform speed U. Pulleys A and B are fixed. Mass M moves upwards with a speed



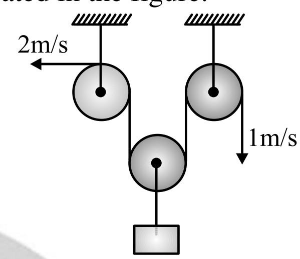
(A) $2U\cos\theta$ (B) $U\cos\theta$
(C) $\frac{2U}{\cos\theta}$ (D) $\frac{U}{\cos\theta}$

7. Find velocity of ring B (V_B) at the instant shown. The string is taut and inextensible.



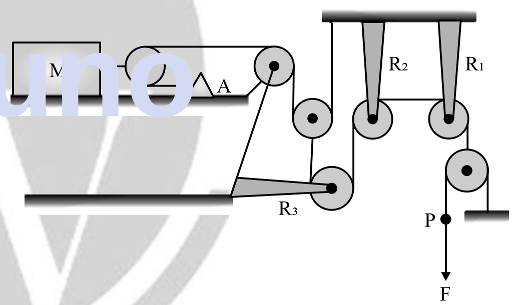
(A) $\frac{1}{2}$ m/s (B) $\frac{\sqrt{3}}{4}$ m/s
(C) $\frac{1}{4}$ m/s (D) 1 m/s

8. Find the velocity of the hanging block if the velocities of the free ends of rope are as indicated in the figure.



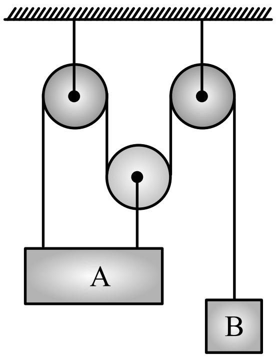
(A) 3/2 m/s↑ (B) 3/2 m/s↓
(C) 1/2 m/s↑ (D) 1/2 m/s↓

9. Find out the magnitude of net force exerted by the pulley on the rod R_1

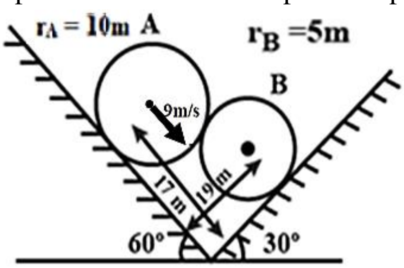


(A) 2 F
(B) F
(C) $2\sqrt{2}F$
(D) $\frac{F}{\sqrt{2}}$

10. At a given instant, A is moving with velocity of 5 m/s upwards. What is velocity of B (in m/s) at that time?



11. System is shown in the figure. Velocity of sphere A is 9 m/s. The speed of sphere B is



(A) 6 m/s
(B) 12 m/s
(C) 10 m/s
(D) 20 m/s

12. **Assertion:** String can never remain horizontal, when loaded at the middle, howsoever large the tension may be.

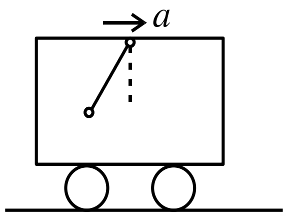
Reason: For horizontal string, angle with vertical, $\theta = 90^\circ, T = \dfrac{W}{2\cos\theta} = \dfrac{W}{2\cos 90^\circ} = \infty$.

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

DPP-6 (JPP/024)

[Pseudo force, Spring Force, Apparent Weight]

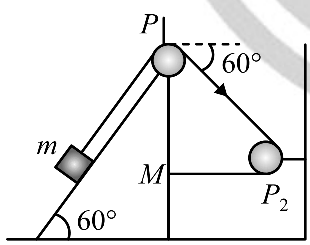
1. A pendulum bob is suspended in a Car moving horizontally with acceleration 'a'. The angle the string will make with vertical is



(A) $\tan^{-1}\frac{g}{a}$ (B) $\tan^{-1}\frac{a}{g}$

(C) $\sin^{-1}\frac{a}{g}$ (D) $\cos^{-1}\frac{a}{g}$

2. In the arrangement shown in the figure, the block of mass m = 2 kg lies on the wedge on mass M = 8 kg. Find the initial acceleration of the wedge if the surfaces are smooth and pulley & strings are massless.



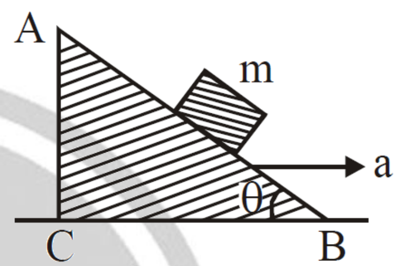
(A) $a = \frac{30\sqrt{3}}{23}\text{ m/s}^2$

(B) $a = \frac{20\sqrt{3}}{23}\text{ m/s}^2$

(C) $a = \frac{20\sqrt{2}}{23}\text{ m/s}^2$

(D) none of these

3. A block of mass m is placed on a smooth inclined wedge ABC of inclination θ as shown in the figure. The wedge is given an acceleration 'a' towards the right. The relation between a and θ for the block to remain stationary on the wedge is:-



(A) $a = \frac{g}{\operatorname{cosec}\theta}$

(B) $a = \frac{g}{\sin\theta}$

(C) $a = g\cos\theta$

(D) $a = g\tan\theta$

4. A car is moving on a plane inclined at 30° to the horizontal with an acceleration of 10 m/s^2 parallel to the plane upward. A bob is suspended by a string from the roof. The angle in degrees which the string makes with the vertical is: (Assume that the bob does not move relative to car)

[g = 10 m/s^2]

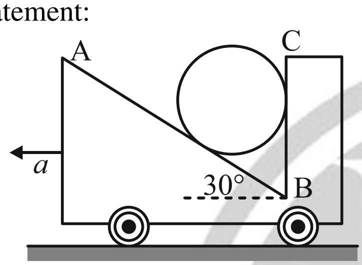
(A) 20°

(B) 30°

(C) 45°

(D) 60°

5. A cylinder rests in a supporting carriage as shown. The side AB of carriage makes an angle 30° with the horizontal and side BC is vertical. The carriage lies on a fixed horizontal surface and is being pulled towards left with an horizontal acceleration 'a'. The magnitude of normal reactions exerted by sides AB and BC of carriage on the cylinder be N_{AB} and N_{BC} respectively. (Neglect friction everywhere). Then as the magnitude of acceleration 'a' of the carriage is increased, pick up the correct statement:



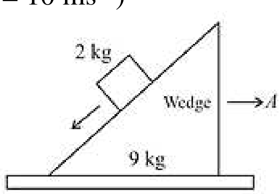
(A) N_{AB} increases and N_{BC} decreases.

(B) Both N_{AB} and N_{BC} increases.

(C) N_{AB} remains constant and N_{BC} increases.

(D) N_{AB} increases and N_{BC} remains constants.

6. A block of mass 2 kg slides down the face of smooth 45° wedge of mass 9 kg as shown in figure. The wedge is placed on a frictionless horizontal surface. Determine the acceleration (in m/s^2) of the wedge. (use g = 10 ms^{-2})



(A) 2 m/s^2

(B) $\frac{11}{\sqrt{2}}$ m/s^2

(C) 1 m/s^2

(D) None of these

7. A body of mass m is placed over a smooth inclined plane of inclination θ, which is placed over a lift which is moving up with an acceleration a_0. Base length of the inclined plane is L. Calculate the velocity of the block with respect to lift at the bottom, if it is allowed to slide down from the top of the plane from rest.

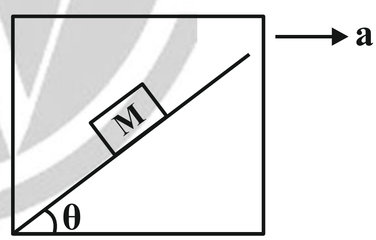
(A) $\sqrt{2(a_0+g)L\sin\theta}$

(B) $\sqrt{2(a_0+g)L\cos\theta}$

(C) $\sqrt{2(a_0+g)L\tan\theta}$

(D) $\sqrt{2(a_0+g)L\cot\theta}$

8. A block is sliding along inclined plane as shown in figure. If the acceleration of chamber is 'a' as shown in the figure. The time required to cover a distance L along inclined plane is



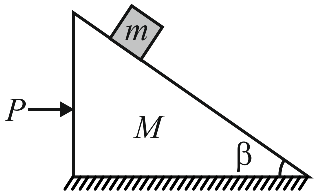
(A) $\sqrt{\frac{2L}{g\sin\theta - a\cos\theta}}$

(B) $\sqrt{\frac{2L}{g\sin\theta - a\sin\theta}}$

(C) $\sqrt{\frac{2L}{g\sin\theta + a\cos\theta}}$

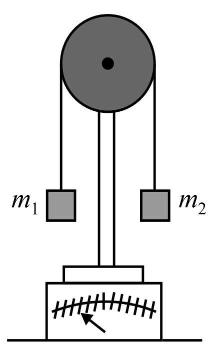
(D) $\sqrt{\frac{2L}{g\sin\theta}}$

9. Two wooden blocks are moving on a smooth horizontal surface such that the mass m remains stationary with respect to block of mass M as shown in the figure. The magnitude of force P is:



(A) $(M + m)\, g \tan \beta$
(B) $g \tan \beta$
(C) $mg \cos \beta$
(D) $(M + m)\, g \operatorname{cosec} \beta$

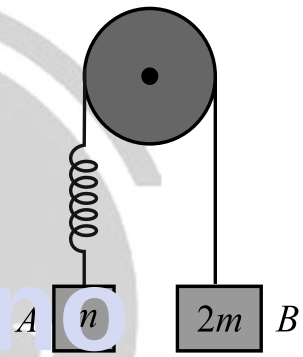
10. Two blocks of masses m_1 and m_2, which are connected with light string, are placed over a frictionless pulley. This set up is placed over a weighing machine, as shown. Three combination of masses m_1 and m_2 are used. In first case $m_1 = 6$ kg and $m_2 = 2$ kg, in second case $m_1 = 5$ kg and $m_2 = 3$ kg and in third case $m_1 = 4$ kg and $m_2 = 4$ kg. Masses are held stationary initially and then released. If the reading of the weighing machine after the release in three cases are W_1, W_2 and W_3 then:



Weighing Machine

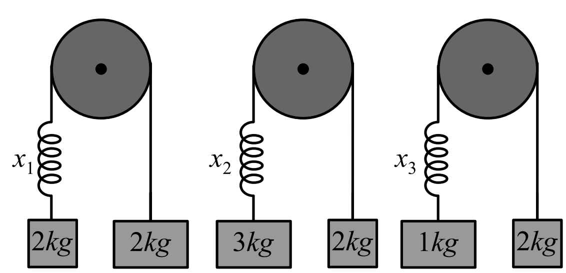
(A) $W_1 > W_2 > W_3$
(B) $W_1 < W_2 < W_3$
(C) $W_1 = W_2 = W_3$
(D) $W_1 = W_2 < W_3$

11. A block 'A' of mass 'm' is attached at one end of a light spring and the other end of spring is connected to another block 'B' of mass 2 m through a light string as shown in the figure. 'A' is held and B is in static equilibrium. Now A is released. The acceleration of A just after that instant is 'a'. In the next case, B is held and A is in static equilibrium. Now when B is released, its acceleration immediately after the release is 'b'. The value of a/b is: (Pully, string and the spring are massless)



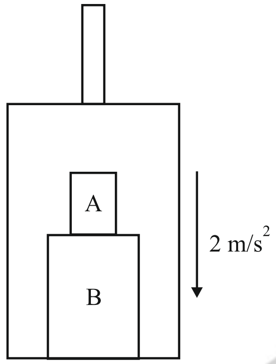
(A) 0
(B) undefined
(C) 2
(D) $\frac{1}{2}$

12. Same spring is attached with 2 kg, 3 kg and 1 kg blocks in three different cases as shown in figure. If x_1, x_2 and x_3 be the extensions in the spring in these cases then (Assume all the blocks to move with uniform acceleration)



(A) $x_1 = 0, x_3 > x_2$
(B) $x_2 > x_1 > x_3$
(C) $x_3 > x_1 > x_2$
(D) $x_1 > x_2 > x_3$

13. The elevator shown in figure is descending with an acceleration of 2 ms^{-2}. The mass of the block A = 0.5 kg. The force exerted by the block A on the block B is



Take $g = 10$ m/s^2

(A) 4 N

(B) 8 N

(C) 10 N

(D) 12 N

14. **Assertion:** Pseudo force is an imaginary force which is recognised only by a non-inertial
observer to explain the physical situation according to Newton's laws.

Reason: Pseudo force has no physical origin, i.e., it is not caused by one of the basic interactions in nature. It does not exist in the action-reaction pair.

(A) Both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

(B) Both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

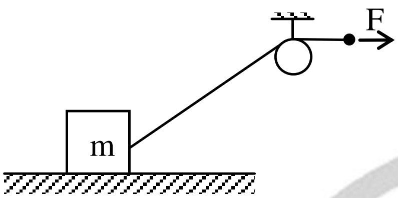
(C) Assertion is True but the Reason is False.

(D) Both Assertion & Reason are False.

DPP-7 (JPP/025)

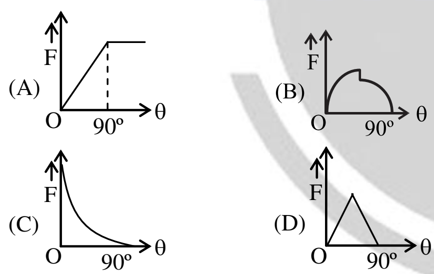
[Friction as a contact force and coefficient of friction, Kinetic and static friction, Angle of friction, Angle of repose]

1. The block of mass m is placed on a rough horizontal floor and it is pulled by a ideal string as shown by a constant force F. As the block moves towards right the frictional force on block-



(A) remains constant (B) increases
(C) decreases (D) can be said

2. A block rests on a rough plane whose inclination θ to the horizontal can be varied. Which of the following graphs indicates how the frictional force F between the block and the plane varies as θ is increased?



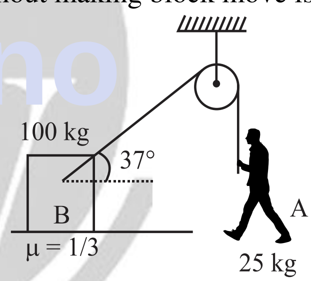
3. Mark the correct statements about the friction between two bodies -
(a) Static friction is always greater than the kinetic friction
(b) Coefficient of static friction is always greater than the coefficient of kinetic friction
(c) Limiting friction is always greater than the kinetic friction
(d) Kinetic friction is independent of area of contact.

(A) b, c, d (B) a, b, c
(C) a, c, d (D) a, b, d

4. If the coefficient of friction between an insect and bowl is μ and the radius of the bowl, is r, the maximum height to which the insect can crawl in the bowl is:

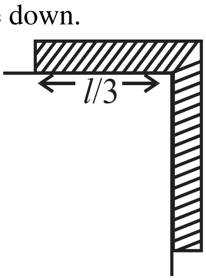
(A) $\frac{r}{\sqrt{1+\mu^2}}$ (B) $r\left[1-\frac{1}{\sqrt{1+\mu^2}}\right]$
(C) $r\sqrt{1+\mu^2}$ (D) $r\sqrt{1+\mu^2}-1$

5. Block B of mass 100 kg rests on a rough surface of friction coefficient μ = 1/3. A rope is tied to block B as shown in figure. The maximum acceleration with which boy A of 25 kg can climbs on rope without making block move is



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

6. Determine the coefficient of friction (μ), so that rope of mass m and length *l* does not slide down.

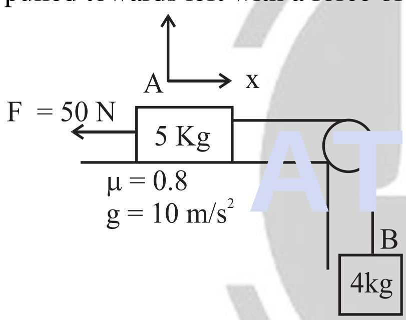


7. A worker wishes to pile a cone of sand into a circular area in his yard. The radius of the circle is r, and no sand is to spill onto the surrounding area. If μ is the static coefficient of friction between each layer of sand along the slope and the sand, the greatest volume of sand that can be stored in this manner is:

(A) $\frac{\pi r^3}{3}$ (B) $\frac{\pi r^3}{3\mu}$

(C) $\frac{\mu\pi r^3}{3}$ (D) $\frac{3\pi r^3}{\mu}$

8. Find the magnitude of frictional force between block A and table, if block A is pulled towards left with a force of 50N.



(A) 10 N
(B) 50 N
(C) 40 N
(D) 30 N

9. A thin rod of length 1m is fixed in a vertical position inside a train, which is moving horizontally with constant acceleration 4 m/s^2. A bead can slide on the rod, and friction coefficient between them is 1/2. If the bead is released from rest at the top of the rod, find the time when it will reach at the bottom.

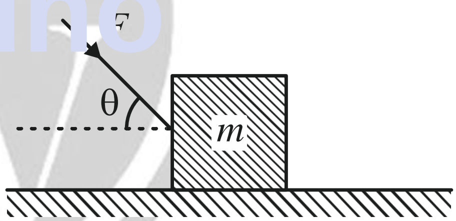
(A) 0.5 second (B) 1 second
(C) 2 second (D) 2.5 second

10. A block of mass 0.1 kg is held against a wall by applying a horizontal force of 5N on the block. If the Coefficient of friction between the block and the wall is 0.5, the magnitude of the frictional force acting on the block is.

(A) 2.5 N
(B) 0.98 N
(C) 4.9 N
(D) 0.49 N

11. **Statement-1**

The maximum value of force F such that the block shown in Fig, does not move is $\frac{\mu mg}{\cos\theta}$, where μ is the coefficient of friction between the block and the horizontal surface.

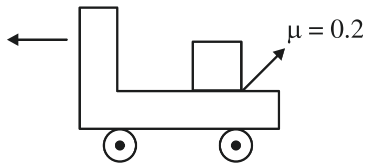


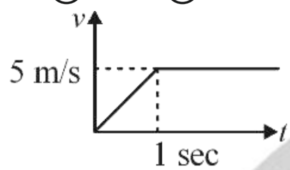
Statement-2

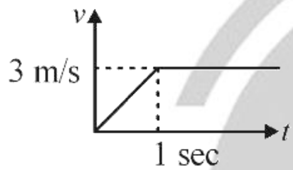
Frictional force = coefficient of friction × normal reaction.

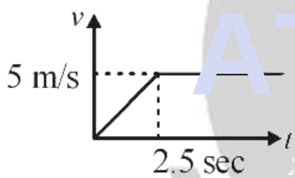
(A) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation for Statement-1.
(B) Statement-1 is true, Statement-2 is true but Statement-2 is not the correct explanation for Statement-1.
(C) Statement-1 is true; Statement-2 is false.
(D) Both Statement-1 and Statement-2 are false.

12. A truck starting from rest moves with an acceleration of 5 m/s^2 for 1 sec and then moves with constant velocity. The velocity w.r.t. ground v/s time graph for block in truck is (Assume that block does not fall off the truck)



(A) 

(B) 

(C) 

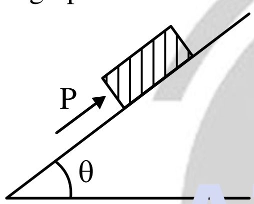
(D) None of these

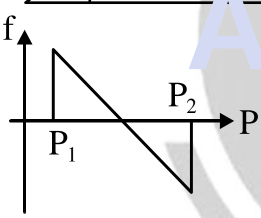
DPP-8

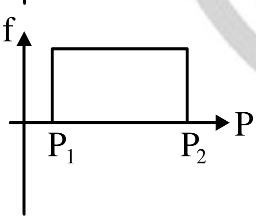
(JPP/026)

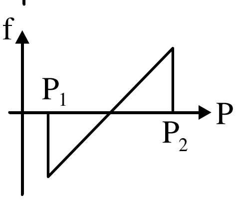
[One or two blocks on inclined plane Blocks on rough horizontal surface, Kinetic Friction and angle of repose]

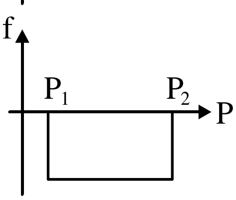
1. A block of mass m is on an inclined plane of angle θ. The coefficient of friction between the block and the plane is μ and $\tan\theta > \mu$. The block is held stationary by applying a force P parallel to the plane. The direction of force pointing up the plane is taken to be positive. As P is varied from $P_1 = mg(\sin\theta - \mu\cos\theta)$ to $P_2 = mg(\sin\theta + \mu\cos\theta)$, the frictional force f versus P graph will be.



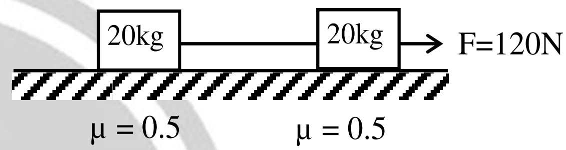
(A)


(B)


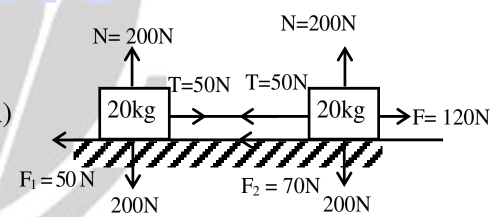
(C)


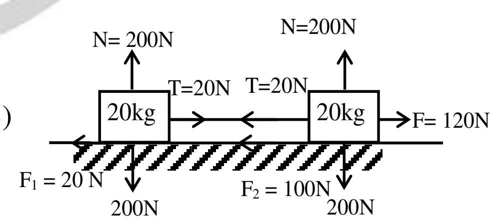
(D)


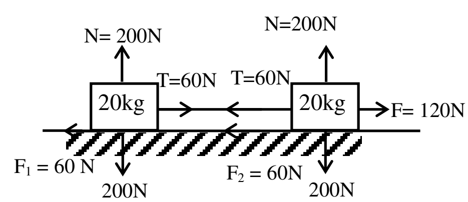
2. Two blocks each of mass 20 kg are connected by an ideal string and this system is kept on rough horizontal surface as shown. Initially the string is just tight then a horizontal force F = 120 N is applied on one block as shown.



If friction coefficient at every contact is μ = 0.5 then which of the following represents the correct free body diagram.

(A)


(B)


(C)


(D) All of the above

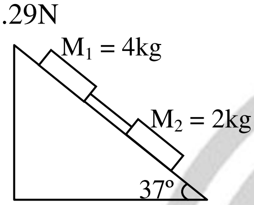
3. Two blocks connected by a massless string slide down an inclined plane having angle of inclination 37°. The masses of the two blocks are $M_1 = 4kg$ and $M_2 = 2kg$ respectively and the coefficients of friction are 0.75 and 0.25 respectively–

(a) The common acceleration of the two masses is nearly 1.3 ms^{-2}

(b) The tension in the string is nearly 14.7N

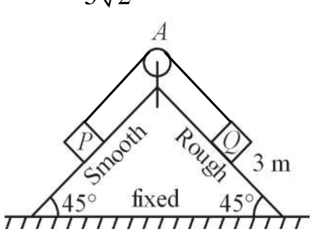
(c) The common acceleration of the two masses is nearly 2.94 ms^{-2}

(d) The tension in the string is nearly 5.29N



(A) a, d (B) c, d
(C) b, d (D) b, c

4. A fixed wedge with both surface inclined at 45° to the horizontal as shown in the figure. A particle P of mass m is held on the smooth plane by a light string which passes over a smooth pulley A and attached to a particle Q of mass 3m which rests on the rough plane. The system is released from rest. Given that the acceleration of each particle is of magnitude $\frac{g}{5\sqrt{2}}$ then



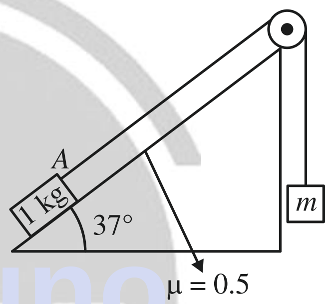
(a) The tension in the string is:

(A) mg (B) $\frac{6mg}{5\sqrt{2}}$

(C) $\frac{mg}{2}$ (D) $\frac{mg}{4}$

5. A block is moving on an inclined plane making an angle 45° with horizontal and the coefficient of friction is μ. the force required to just push it up the inclined plane is 3 times the force required to just prevent it from sliding down. If we define N = 10μ, then N is

6. In the figure, what should be mass m (in kg) so that block A slides up with a constant velocity.



7. A small mass slides down an inclined plane of inclination θ with the horizontal. The co-efficient of friction is $\mu = \mu_0 x$ where x is the distance through which the mass slides down and μ_0, a constant. Then the distance covered by the mass before it stops is:

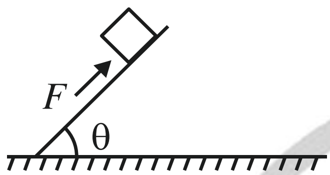
(A) $\frac{2}{\mu_0}\tan\theta$

(B) $\frac{4}{\mu_0}\tan\theta$

(C) $\frac{1}{2\mu_0}\tan\theta$

(D) $\frac{1}{\mu_0}\tan\theta$

8. A block placed on a rough inclined plane of inclination (θ =30°) can just be pushed upwards by applying a force "F" as shown. If the angle of inclination of the inclined plane is increased to (θ = 60°), the same block can just be prevented from sliding down by application of a force of same magnitude. The coefficient of friction between the block and the inclined plane is



(A) $\frac{\sqrt{3}+1}{\sqrt{3}-1}$ (B) $\frac{2\sqrt{3}-1}{\sqrt{3}+1}$

(C) $\frac{\sqrt{3}-1}{\sqrt{3}+1}$ (D) None of these

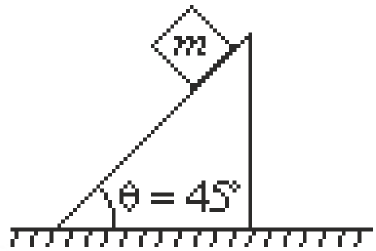
9. A block of mass 'M' is slipping down on a rough incline of inclination α with horizontal with a constant velocity. The magnitude and direction of total reaction from the inclined plane on the block is :

(A) Mg sin α down the incline
(B) less than Mg sin α down the incline
(C) Mg upwards
(D) Mg downwards

10. A block kept on an inclined surface, just begins to slide if the inclination is 30°. The block is replaced by another block B and it just begins to slide if the inclination is 40°, then:

(A) Mass of A > mass of B
(B) Mass of A < mass of B
(C) Mass of A = mass of B
(D) All the three are possible

11. A wedge of mass 2 *m* and a cube of mass *m* are shown in figure. Between cube and wedge, there is no friction. The minimum coefficient of friction between wedge and ground so that wedge does not move is:



(A) 0.20
(B) 0.25
(C) 0.10
(D) 0.50

12. **Statement 1:** A block of mass m is placed on smooth fixed inclined plane of inclination θ with the horizontal. The force exerted by the plane on the block has a magnitude mg cos θ.

Statement 2: Normal reaction always acts perpendicular to the contact surface.

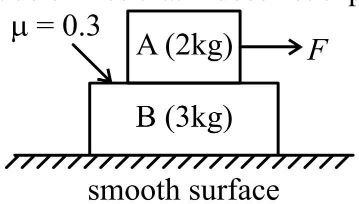
(A) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation for Statement-1.
(B) Statement-1 is true, Statement-2 is true but Statement-2 is not the correct explanation for Statement-1.
(C) Statement-1 is true; Statement-2 is false.
(D) Statement-1 is false; Statement-2 is true.

DPP-9

(JPP/027)

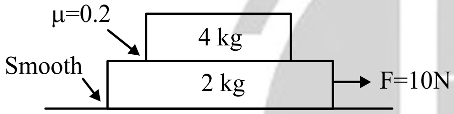
[Block Over Block Problems]

1. For the system shown find the maximum value of *F* so that *A* does not slip on *B*.



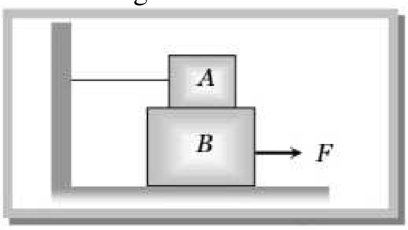
(A) 10 N
(B) 5 N
(C) 6 N
(D) 12 N

2. Find the friction acting between the blocks.



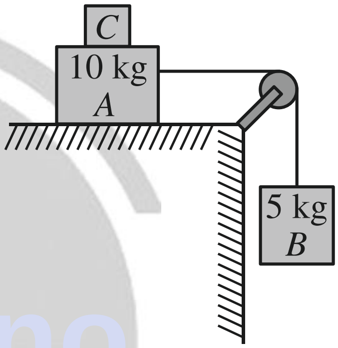
(A) 8 N
(B) 6 N
(C) $\frac{20}{3}$ N
(D) 4 N

3. A block *A* with mass 100 kg is resting on another block *B* of mass 200 kg. As shown in figure a horizontal rope tied to a wall holds it. The coefficient of friction between *A* and *B* is 0.2 while coefficient of friction between *B* and the ground is 0.3. The minimum required force *F* to start moving B will be



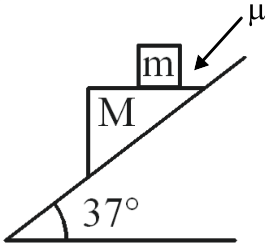
(A) 900 N
(B) 100 N
(C) 1100 N
(D) 1200 N

4. Two masses A and B of 10 kg and 5kg respectively are connected with a string passing over a frictionless pulley fixed at the corner of a table as shown in figure. The coefficient of friction of A with the table is 0.2. The minimum mass of C that may be placed on A to prevent it from moving is equal to:



(A) 15 kg
(B) 10 kg
(C) 5 kg
(D) Zero

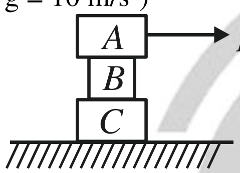
5. Block M slides down on frictionless incline as shown. Find the minimum friction coefficient so that m does not slide with respect to M.



(A) $\frac{3}{4}$
(B) $\frac{4}{5}$
(C) 2
(D) 0

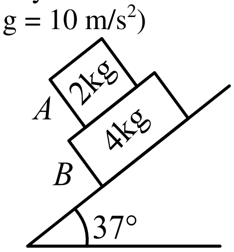
6. A block A of mass 2kg rests on another block B of mass 8kg which rests on a horizontal floor. The coefficient of friction between A and B is 0.2 while that between B and floor is 0.5. When a horizontal force F of 25N is applied on the block *B*, the force of friction between A and B is __________N.

7. Given m_A = 30 kg, m_B= 10 kg, m_C = 20 kg. Between A & B μ_1 = 0.3, between B & C μ_2 = 0.2 & between C & ground μ_3 = 0.1. The least horizontal force F to start motion of any part of the system of three blocks resting upon one another as shown below is:
(Take g = 10 m/s^2)



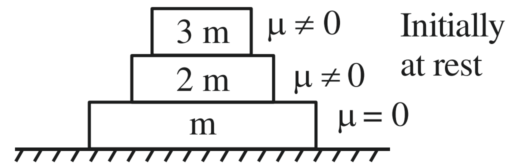
(A) 90 N
(B) 80 N
(C) 60 N
(D) 150 N

8. Consider the situation shown in figure in which a block 'A' of mass 2 kg is placed over a block 'B' of mass 4 kg. The combination of the blocks are placed on a inclined plane of inclination 37° with horizontal and coefficient of friction between *B* and inclined plane is μ_2. The coefficient of friction between blocks is μ_1. The system is released from rest.
(Take g = 10 m/s^2)



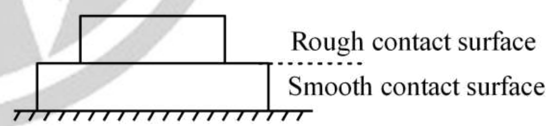
If $\mu_1 = 0.8, \mu_2 = 0.8$ then:
(A) both blocks will move together
(B) only block A will move and block B remains at rest
(C) Only block B will move and block A remains at rest
(D) None of the blocks will move

9. When a horizontal force is applied on the bottom block, the accelerations of the blocks (in m s^{-2}) are (starting from top) 1, 2 and 3 respectively (g = 10 m s^{-2})



μ between m and 2 m is
(A) 0.14
(B) 0.23
(C) 0.32
(D) 0.41

10. **Statement-1:** It is found that the two bodies shown are moving as a single unit, there must be external force(s) acting on either on both bodies horizontally, or having a horizontal component.
Statement-2: When an opposing force is present, motion is possible only when an external force overcomes it.



(A) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation for Statement-1.
(B) Statement-1 is true, Statement-2 is true but Statement-2 is not the correct explanation for Statement-1.
(C) Statement-1 is true; Statement-2 is false.
(D) Statement-1 is false; Statement-2 is true.

DPP-10 (JPP/028)

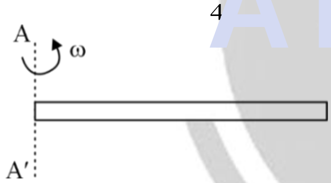
[Acceleration in Circular motion, Dynamics of Circular Motion]

1. A person with a mass of M kg stands in contact against the wall of the cylindrical drum of radius r rotating with an angular velocity ω. The coefficient of friction between the wall and the clothing is μ. The minimum rotational speed of the cylinder which enables the person to remain stuck to the wall when the floor is suddenly removed is -

(A) $\omega_{min} = \sqrt{\frac{g}{\mu r}}$ (B) $\omega_{min} = \sqrt{\frac{\mu r}{g}}$

(C) $\omega_{min} = \sqrt{\frac{2g}{\mu r}}$ (D) $\omega_{min} = \sqrt{\frac{gr}{\mu}}$

2. A uniform rod of mass m and length L is rotated with angular speed ω about axis AA' as shown in figure. The tension in the rod at a distance of $\frac{3L}{4}$ from the axis is



(A) $\frac{3m\omega^2 L}{4}$ (B) $\frac{m\omega^2 L}{8}$

(C) $\frac{7m\omega^2 L}{32}$ (D) $\frac{7m\omega^2 L}{8}$

3. A stone is thrown horizontally with a velocity of 10 m/s at t = 0. The radius of curvature of the stone's trajectory at t = 3 s is:

[Take g = 10 m/s^2]

(A) $10\sqrt{10}$ m

(B) 100 m

(C) $100\sqrt{10}$ m

(D) 1000 m

4. In circular motion of a particle the tangential acceleration of the particle is given by a_t = 2t m/s^2. The radius of the circle described is 4m. The particle is initially at rest. Time after which net force on the particle makes 45° with radial acceleration is:

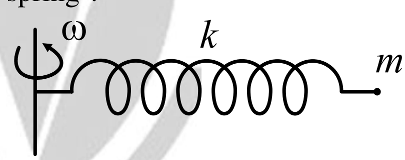
(A) 1 sec

(B) 2 sec

(C) 3 sec

(D) 4 sec

5. In the figure, the spring is horizontal, its natural length is l and gravity is absent if the spring is whirled with an angular speed ω what is the new length of the spring ?



(A) $\frac{m\omega^2 l}{k+m\omega^2}$ (B) $\frac{m\omega^2 l}{k-m\omega^2}$

(C) $\frac{kl}{k+m\omega^2}$ (D) $\frac{kl}{k-m\omega^2}$

6. A particle of mass m rotates about Z-axis in a circle of radius a with a uniform angular speed ω. It is viewed from a frame rotating about the same Z-axis with a uniform angular speed ω_0. The centrifugal force on the particle is :

(A) $m\omega^2 a$ (B) $m\omega_0^2 a$

(C) $m\left(\frac{\omega+\omega_0}{2}\right)^2 a$ (D) $m\omega\omega_0 a$

7. A particle of mass m_1 is fastened to one end of a massless string and another particle of mass m_2 is fastened to the middle point of the same string. The other end of the string being fastened to a fixed point on a smooth horizontal table. The particles are then projected, so that the two particles and the string are always in the same straight line and describe horizontal circles. Then, the ratio of tensions in the inner string to the outer string is :

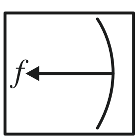
(A) $m_1/(m_1+m_2)$

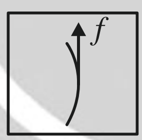
(B) $(m_1+m_2)/m_1$

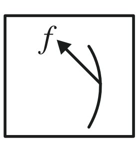
(C) $(2m_1+m_2)/2m_1$

(D) $2m_1/(m_1+m_2)$

8. Indicate the direction of frictional force on a car which is moving along the curved path with non-zero tangential acceleration; in anti-clock direction:

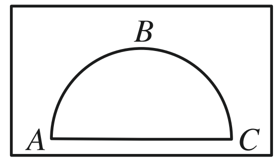
(A) 

(B) 

(C) 

(D) 

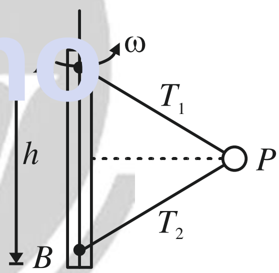
9. If a particle starts from A along the curved circular path shown in figure with tangential acceleration 'a'. Then acceleration at B in magnitude is :



(A) $2a\sqrt{1+\pi^2}$ (B) $a\sqrt{1+\pi^2}$

(C) $a\sqrt{\pi^2-1}$ (D) $a\pi\sqrt{1+\pi^2}$

10. A particle P is attached by means of two equal strings to two points A and B in same vertical line and describes horizontal circle with uniform angular speed $2\sqrt{\frac{2g}{h}}$ where AB = h.



(A) $T_1 : T_2 = 9 : 7$

(B) $T_1 : T_2 = 5 : 3$

(C) $T_1 : T_2 = \sqrt{5} : \sqrt{3}$

(D) $T_1 = T_2$

DPP-11 (JPP/029)

[Dynamics of circular motion and Banking of road and conical pendulum]

1. A simple pendulum is made of bob of mass m and using string of length L fixed at upper end. The bob oscillates in vertical circle. It is found that speed of the bob is v when the string makes an angle θ with the vertical. The tension T at this instant is-

(A) $T = mg\cos\theta$

(B) $T = mg\cos\theta - \frac{mv^2}{L}$

(C) $T = \frac{mv^2}{L}$

(D) $T = mg\cos\theta + \frac{mv^2}{L}$

2. A motor cyclist moving with a velocity of 72 km per hour on a flat road takes a turn on the road at a point where the radius of curvature of the road is 20 meters. The acceleration due to gravity is 10 m/s^2. In order to negotiate the turn, he must bend at an angle of,

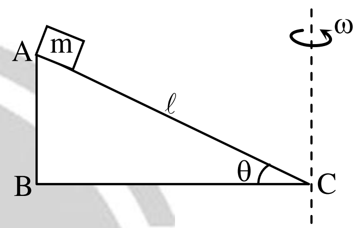
(A) $\theta = \tan^{-1} 6$

(B) $\theta = \tan^{-1} 2$

(C) $\theta = \tan^{-1} 25.92$

(D) $\theta = \tan^{-1} 4$

3. A block of mass m is placed at the top of a smooth wedge ABC. The wedge is rotated about an axis passing through C as shown in the figure. The minimum value of angular speed ω such that the block does not slip on the wedge is-



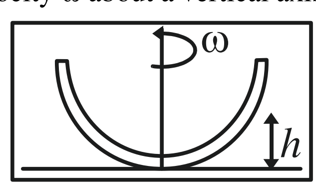
(A) $\left(\sqrt{\frac{g\sin\theta}{\ell}}\right)\sec\theta$

(B) $\left(\sqrt{\frac{g}{\ell}}\right)\cos\theta$

(C) $\left(\sqrt{\frac{g}{\ell\cos\theta}}\right)\cos\theta$

(D) $\sqrt{\frac{g\sin\theta}{\ell}}$

4. A small body of mass m can slide without friction along a trough bend which is in the from of a semi-circular arc of radius R. At what height h will the body be at rest with respect to the trough, if the trough rotates with uniform angular velocity ω about a vertical axis:



(A) R

(B) $R - \frac{2g}{\omega^2}$

(C) $R + \frac{2g}{\omega^2}$

(D) $R - \frac{g}{\omega^2}$

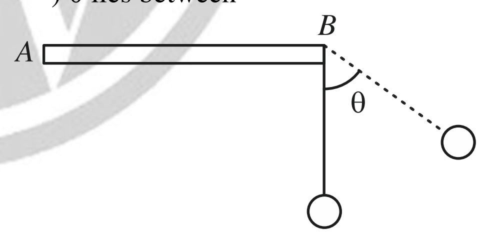
5. A curved section of road is banked for a speed v. If there is no friction between the road and the tyres then:
(A) a car moving with speed v does not slip on the road
(B) a car is more likely to slip on the road at speed higher than v, than at speeds lower than v
(C) a car is more likely to slip on the road at speeds lower than v, than at speeds higher than v
(D) a car can remain stationary on the road with slipping

6. A particle of mass m is attached to one end of a string of length l while the other end is fixed to point h ($h < l$) above a horizontal table. The particle is made to revolve in a circle on the table so as to make p revolutions per second. The maximum value of p, if the particle is to be in contact with the table, is: ($l > h$)
(A) $\frac{1}{2\pi}\sqrt{h/g}$
(B) $\sqrt{g/h}$
(C) $2\pi\sqrt{h/g}$
(D) $\frac{1}{2\pi}\sqrt{g/h}$

7. A smooth hollow cone whose vertical angle is 2α with its axis vertical and vertex downwards revolves about its axis ηtime per seconds. A particle is placed on the inner surface of cone so that it rotates with same speed. The radius of rotation for the particle is:
(A) $g\cot\alpha/4\pi^2\eta^2$
(B) $g\sin\alpha/4\pi^2\eta^2$
(C) $4\pi^2\eta^2/g$
(D) $g/4\pi^2\eta^2\sin\alpha$

8. A body moves on a horizontal circular road of radius r, with a tangential acceleration a_T. Coefficient of friction between the body and road surface is μ. It begins to slip when it's speed is v, then:
(A) $v^2 = \mu rg$
(B) $\mu g = \frac{v^2}{r} + a_T$
(C) The force of friction makes an angle $\tan^{-1}\left(\frac{a_T \times r}{v^2}\right)$ with direction of motion at point of slipping.
(D) $\mu^2 g^2 = \frac{v^4}{r^2} + a_T^2$

9. A horizontal rod AB of length 1 m, with a 1 m long light, inextensible string with a bob attached to it and suspended from end B is rotated on the horizontal plane about point A at a constant angular velocity of $\sqrt{10}$ rad s^{-1} so that the string makes angle θ with vertical. ($g = 10$ m s^{-2}) θ lies between



(A) 0° and 30°
(B) 30° and 45°
(C) 45° and 65°
(D) 65° and 90°

10. A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45°, the speed of the car is:
(A) 20 ms^{-1}
(B) 30 ms^{-1}
(C) 5 ms^{-1}
(D) 10 ms^{-1}