IIT – JEE 2017 **PHYSICS ASSINGMENT** **DATE: 08-04-2017**
TOPIC: MECHANICS - 1

Single Choice type Question:

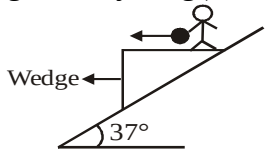
1. The displacement of a particle moving in a straight line is described by the relation, $s = 6 + 12t - 2t^2$. Here s is in meters and t in seconds. The distance covered by particle in first 5 seconds is :
(a) 20 m (b) 32 m (c) 24 m (d) 26 m

2. A ball is thrown horizontally with velocity 30 m/s from top of a 60 m high tower. simultaneously, another ball is thrown vertically upward with velocity 40 m/s from the bottom of same tower. The shortest distance between the two balls is ($g = 10\ m/s^2$)
(a) 36 m (b) 48 m (c) 60 m (d) 45 m

3. A particle is moving in x-y plane. At certain instant, the components of its velocity and acceleration are as follows $V_x = 3$ m/s , $V_y = 4$ m/s, $a_x = 2\ m/s^2$ and $a_y = 1\ m/s^2$. The rate of change of speed at this moment is (in m/s^2)
(A) 4 (B) 2 (C) $\sqrt{3}$ (D) $\sqrt{5}$

4. A box of mass 1 kg is lying on a rough horizontal floor and a horizontal force acting on box has a magnitude of $F = 3t^2$ N, where t is in seconds. If the box starts from rest, determine its speed (in m/s) when t = 3 sec. The coefficient of static and kinetic friction between the box and horizontal floor are $\mu_s = 0.3$ and $\mu_k = 0.2$.
(A) 18 (B) 20 (C) 22 (D)24

5. A wedge can slide frictionlessly on a fixed incline of angle 37°. A girl who is strapped on the wedge [no relative motion between wedge and girl] pushes a small ball on the horizontal smooth upper surface of wedge as shown in figure. Ball is pushed at the same instant as the motion of wedge starts. Initial velocity of ball is 24 m/s relative to wedge. The time (in sec) after which ball returns to girl is
(Assume that horizontal surface of wedge is very long.)



(A) 10 (B) 12 (C) 8 (D) 6

6. Two particles are projected from same point on ground in two mutually perpendicular planes with same initial speed u at same angle 60° above horizontal. If acceleration due to gravity be 'g', the time instant at which their velocities are inclined at 60° with each other is/are -
(A) $\frac{\sqrt{3}u}{2g}$ (B) $\left(\sqrt{3}-1\right)\frac{u}{2g}$ (C) $\frac{\left(\sqrt{3}+1\right)u}{2g}$ (D) never attained.

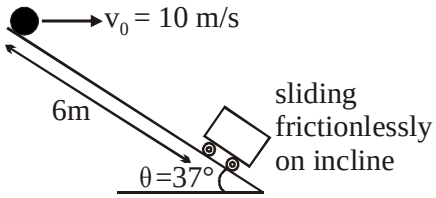
7. When the gap is closed without placing any object in the screw gauge whose least count is 0.005 mm, the 5^{th} division on its circular scale with the reference line on main scale, and when a small sphere is placed reading on main scale advances by 4 divisions, whereas circular scale reading advances by five times to the corresponding reading when no object was placed. There are 200 divisions on the circular scale. The radius of the sphere is

(A) 4.10 mm (B) 4.05 mm (C) 2.10 mm (D) 2.05 mm

8. A particle moves along x-axis following the relation $px^2 + qv^2 = r$ where p, q, r are positive constants, x is co-ordinate of the particle and v is the instantaneous speed. The time interval between two consecutive instants, when particle is at rest is

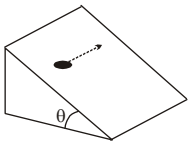
(A) $2\pi\sqrt{\frac{p}{q}}$ (B) $\pi\sqrt{\frac{p}{q}}$ (C) $\pi\sqrt{\frac{q}{p}}$ (D) None

9. A ball is projected horizontally from an incline so as to strike a cart sliding on the incline. Neglect height of cart and point of projection of ball above incline. At the instance the ball is thrown, the speed of cart is



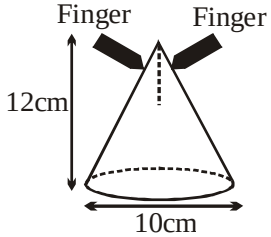
(A) 4 (B) 6 (C) 8 (D) None of these

10. An object of mass m rests on an inclined plane that makes angle $\theta = 45^0$ with the horizontal floor. What minimum force (in N), parallel to the incline must be applied to the object in order to move it along the plane parallel to the floor as shown? The coefficient of static friction between the object and the plane is μ



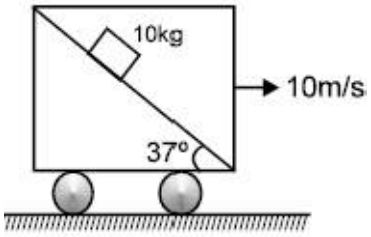
(A) mg (B) $\sqrt{2}$ mg (C) $\frac{mg}{\sqrt{2}}$ (D) $\frac{mg}{2}$

11. With two fingers, you hold a cone motionless upside down, as shown in figure. The mass of the cone is m = 1kg, and the coefficient of static friction between your fingers and the cone is (μ = 0.5). What is the minimum normal force (in Newton) you must apply with each finger in order to hold up the cone ?



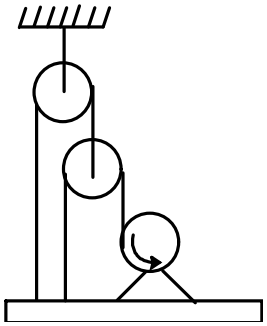
(A) 30 (B) 65 (C) 25 (D) 20

12. A block of mass 10 kg is released on a fixed wedge inside a cart which is moving with a constant velocity of 10 m/s towards right. The initial velocity of the block w.r.t the cart is zero. The work done by normal reaction (with respect to ground) on the block in two seconds is $\left[g = 10\,m/s^2 \right]$



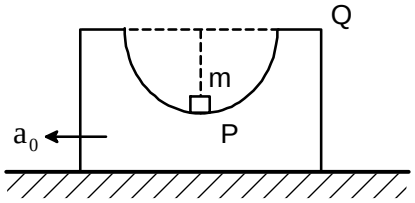
(A) Zero (B) 1200 J (C) 1024 J (D) 960 J

13. If in the arrangement shown, motor runs winding rope at a rate of v m/s the upward speed of plat form will be



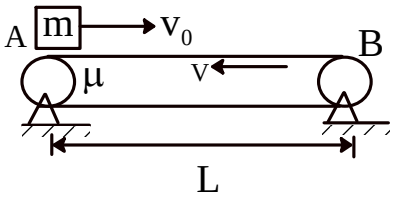
(a) $\frac{v}{3}$ (b) $\frac{v}{4}$ (c) $\frac{v}{7}$ (d) none of these

14. A small block of mass *m* is lying at rest at point *P* of a wedge having a smooth semi circular track of radius *R*. The minimum value of horizontal acceleration a_0 of wedge so that mass can just reach the point Q?



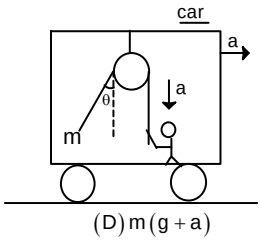
(a) g/2 (b) $\sqrt{g}$ (c) g (d) not possible

15. With what minimum velocity should block be projected from left end A towards end B such that it reaches the other end B of conveyor belt moving with constant velocity v. Friction coefficient between block and belt is μ.



(a) $\sqrt{\mu gL}$ (b) $\sqrt{2\mu gL}$ (c) $\sqrt{3\mu gL}$ (d) $2\sqrt{\mu gL}$

16. A bob is hanging over a pulley inside a car through a string. The second end of the string is in the hand of a person standing in the car. The car is moving with constant acceleration 'a' directed horizontally as shown in figure. Other end of the string is pulled with constant acceleration 'a' vertically. The tension in the string is equal to



(A) $m\sqrt{g^2+a^2}$ (B) $m\sqrt{g^2+a^2}-ma$ (C) $m\sqrt{g^2+a^2}+ma$ (D) $m(g+a)$

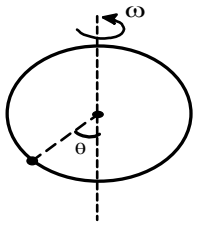
17. A particle is moving in a circle of radius R in such a way that at any instant the total acceleration makes an angle of 45^0 with the radius vector. If the initial speed of the particle is v_0 then the time taken by the particle to complete the first revolution is

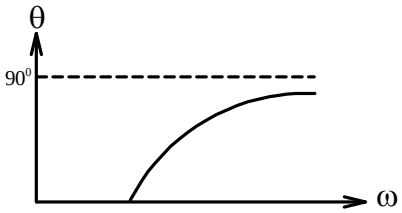
(A) $\frac{R}{v_0}e^{-2\pi}$ (B) $\frac{R}{v_0}\left[1-e^{-2\pi}\right]$ (C) $\frac{2R}{v_0}e^{-2\pi}$ (D) $\frac{2R}{v_0}\left[1-e^{-2\pi}\right]$

18. Three ships A, B and C are in motion. The motion of A as seen by B is v along north-east. The motion of B as seen by C is speed v towards the north-west. Then as seen by A, C will be moving towards-

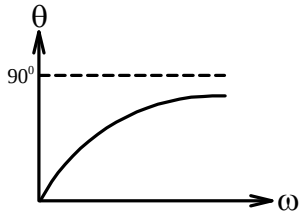
(a) North (b) South (c) East (d) West

19. A bead can slide without friction on a circular loop lying in a vertical plane. Now the loop rotates at a constant angular velocity ω about a vertically diameter (see figure). Angle θ (taken from vertical) at which the bead is in vertical equilibrium is plotted against ω. Is best represented by :





(A)



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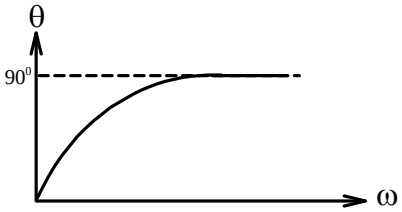
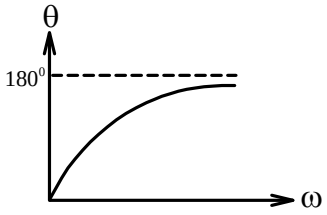
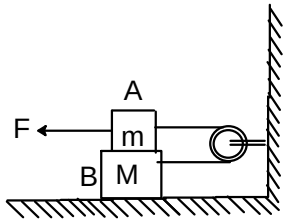


(C)



(D)

20. Two blocks A and B masses m and M are placed as shown in the figure. The friction coefficient between A and B , and between B and ground is μ .What maximum horizontal force F can be applied at A without disturbing the equilibrium of the system is



(A) $\mu mg + \mu Mg$ (B) $\frac{\mu mg}{2} + \frac{3\mu Mg}{2}$ (C) $3\mu mg + \mu Mg$ (D) $2\mu Mg - \mu mg$

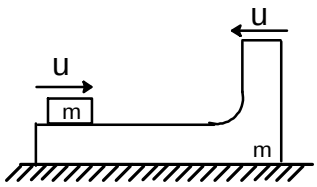
More than type question:

21. A particle moves in a circle of radius R, with a constant speed v. Then, during a time interval [πR/3v], which of the following is true?

(A) | average acceleration | = $3v^2/\pi R$ (B) | average velocity | = $3v/\pi$

(C) | average acceleration | = $2v^2/\pi R$ (D) average speed = $3v/\pi$

22. A small block of mass m is placed on a smooth wedge of mass 'm' the combination is placed on a smooth horizontal surface and are given velocities u towards each other as shown in the diagram. The maximum height to which the small block of mass m rises after breaking off the vertical section of the wedge is H, relative to its initial level



(A) $u = \sqrt{gH}$

(B) Initial momentum of system is zero

(C) The final velocity of the small block at its height point is zero

(D) The horizontal speed of the system when the smaller block is at its highest point of wedge is $\sqrt{2}u$.

23. The surface tension phenomenon is the result of the tendency of a system to keep total

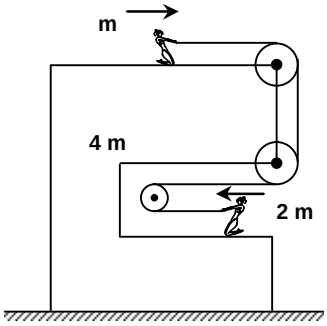
(A) density of the system minimum

(B) potential energy minimum

(C) volume of the system minimum

(D) surface area of the system minimum

24. A wedge of mass 4 m lies on a smooth horizontal surface as shown in the figure. The wedge has two men of masses m and 2m. The system is initially at rest. The man of mass 2m starts pulling the rope so that his acceleration with respect to wedge is 2a towards left. The acceleration of m is a towards right (with respect to wedge). The string & pulleys are massless and the coefficient of friction between each man and wedge is μ.



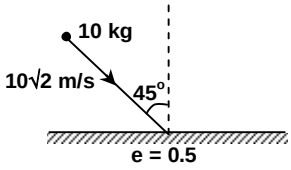
(A) The acceleration of the wedge is 3a/7 towards right

(B) The magnitude of acceleration of m with respect to ground is 10a/7

(C) The tension in the string is through out 10 ma/7

(D) The force exerted by both the men on the rope is same.

25. A ball of mass 10kg hits a rough horizontal surface (μ =0.5) with a speed of $10\sqrt{2}$ m/s at an angle of 45^o as shown in the figure. The coefficient of restitution between the ball and the surface is 0.5 and the ball remains in contact with the surface for 0.1 sec. $\vec{F}$ is the instantaneous force exerted by the surface on ball at any time t during the collision.



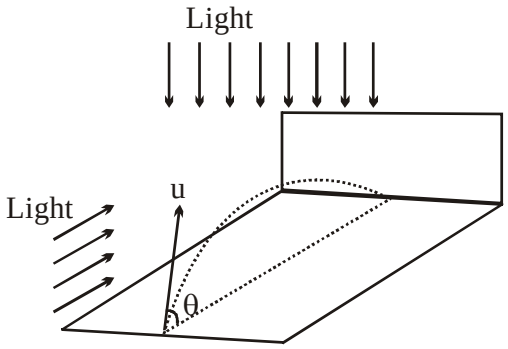
(A) The speed with which the ball rebounds is $\frac{5\sqrt{5}}{2}$ m/s

(B) During collision $|\vec{F}|$ may be more than, less than or equal to $\sqrt{1600^2+750^2}$ N

(C) During collision $|\vec{F}|$ may be greater than or equal to 100 N

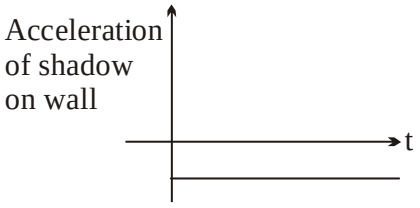
(D) The average force exerted by ground during collision is $\sqrt{1600^2+750^2}$ N

26. A projectile is projected as shown in figure. A proper light arrangement makes a shadow on the wall as well as on the floor ?

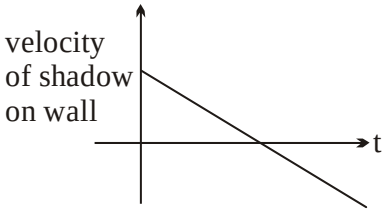


Which of the following graphs is incorrect.

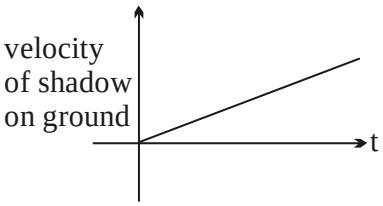
(A)



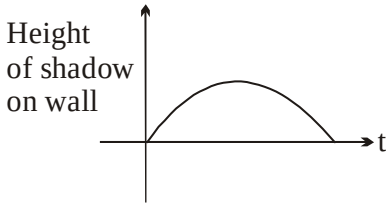
(B)



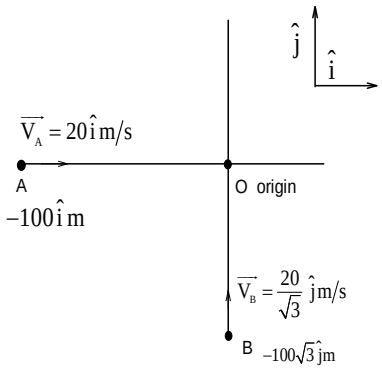
(C)



(D)



27. Position of 2 vehicles A and B with reference to origin O and their velocities are as shown at time instant t = 0. If they move with constant velocities as shown. Choose the correct statement (s)



(A) Distance of closest approach is 100m

(B) Magnitude of relative velocity is $\frac{40}{\sqrt{3}}$ m/s

(C) The instant at which they are closest to each other is t = 7.5 s.

(D) All above statements are false.

28. A particle moving with speed V changes its direction of motion by angle θ without change in speed. Choose the correct statement (s)

(A) Magnitude of change of velocity is $2V\sin\frac{\theta}{2}$

(B) Magnitude of change of velocity is zero

(C) Change in magnitude of velocity is zero

(D) All above statements are false

29. Two identical bodies are interconnected with a massless and inextensible thread. The system is in gravity free space with the thread just taut. Each ball is imparted a velocity v, one towards the other ball and the other perpendicular to the first, at $t = 0$. Then,

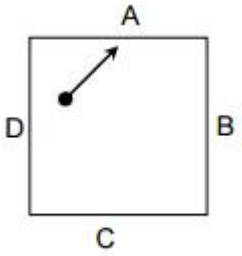
(a) the thread will become taut at $t = (L/v)$

(b) the thread will become taut at some time $t < (L/v)$

(c) the thread will always remain taut for $t > (L/v)$

(d) the kinetic energy of the system will always remain mv^2

30. A smooth uniform square wall frame of mass m of edge length 2a and small height lies in a smooth horizontal plane. At t =0 a particle of mass m hits with speed $v\sqrt{2}$, one of the inner wall of the frame horizontally at an angle 45^0 from wall normal. Collision is perfectly elastic. The initial collision takes place at the mid point of wall A.



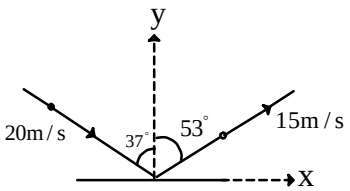
(A) Next collision takes place when t= $\frac{a}{v}$

(B) KE of frame when t= $\frac{3a}{2v}$ is mv^2

(C) after collision at B next collision takes place at wall D

(D) particle and frame comes to rest at regular intervals of time

31. A ball of mass 2 kg strikes a floor as shown in figure. For this situation mark the correct statement(s)



(A) The impulse experienced by ball during the collision is acting along the +ve y-direction and is having a magnitude of 50 $N-S$.

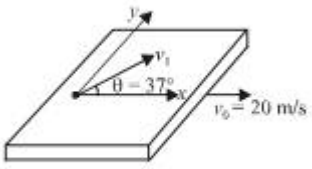
(B) Floor may be rough or smooth

(C) Coefficient of restitution between floor and ball is $\frac{9}{16}$

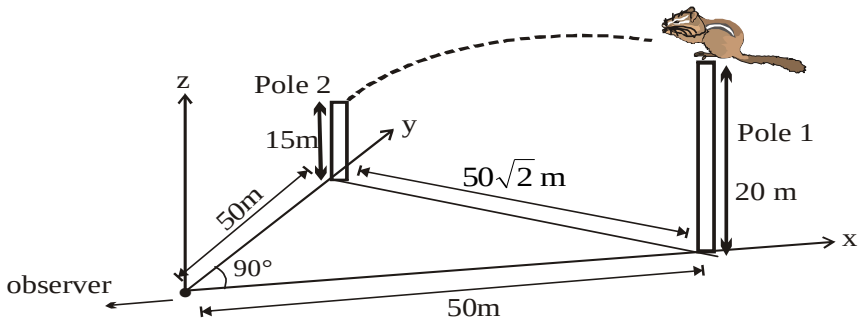
(D) The direction of impulse experienced by ball during the collision is along somewhere between the y axis and $-$ve x – axis.

Integer type question:

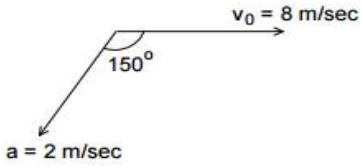
32. A horizontal board is being moved with a constant velocity v_0 on a smooth horizontal plane. A small block is projected on the block with velocity v_1 = 25 m/s at an angle 37° relative to the ground. The coefficient of friction between the block and the board is 0.3. If velocity of block (in m/s) relative to ground after time t = 10 sec. is v than v/10 is equal to?



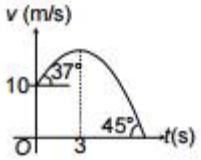
33. A small squirrel jumps from pole 1 to pole 2 in horizontal direction. Squirrels is observed by a very small observer at origin. If average velocity vector is expressed as $v_x\hat{i}+v_y\hat{j}+v_z\hat{k}$, then value of $\frac{\left(|v_x|+|v_y|+|v_z|\right)}{21}$ (in unit m/s) is



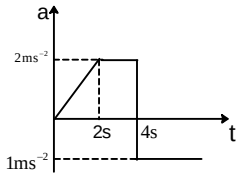
34. The figure shows the velocity and acceleration of a point like body at the initial moment of its motion. The acceleration vector of the body remains constant. The minimum radius of curvature of trajectory of the body is



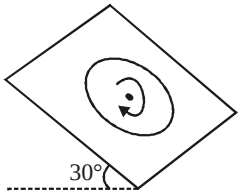
35. A particle starts moving with velocity 10 m/s in a straight line under an acceleration varying linearly with time. Its velocity time graph is as shown in figure. Its velocity is maximum at t = 3 sec. Find the time (in sec) when the particle stops.



36. The acceleration time graph of a particle moving in one dimension is shown. The time at which the velocity of the particle is the same as its velocity at $t = 0$ is t_0. Find $\frac{t_0}{2}$ (particle is initially at rest)



37. An old record player of 10 cm radius turns at 10 rad/s while mounted on a 30° incline as shown in the figure. A particle of mass m can be placed any where on the rotating record. If the least possible coefficient of friction μ that must exist for no slipping to occur is μ, find $2\sqrt{3}\mu$.



38. A block of mass 1 kg start moving at t = 0 with speed 2 m/s on rough horizontal surface with coefficient of friction 0.2. A horizontal force F is applied in the direction of velocity which varies with time shown in figure (B). Find the speed (in m/s) of particle at t = 3 s.

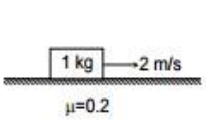
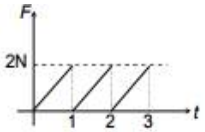
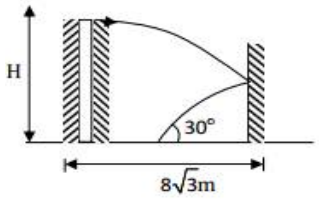


Figure (a)



Figure

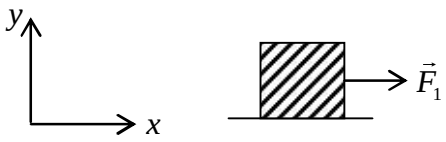
39. A ball is thrown horizontally from the top of a tower of unknown height. Ball strikes a vertical wall whose plane is normal to the plane of motion of ball. Collision is elastic and ball falls on ground exactly at the midpoint between the tower and the wall. Ball strikes the ground at an angle of the 30° with horizontal. Find the height of the tower (in meter).



Comprehensive Type Question:

PARAGRAPH FOR QUESTIONS NOS. 40 TO 42

A block of mass 3kg is lying on a rough horizontal surface. The block is acted upon by two forces $\vec{F}_1$ & $\vec{F}_2$ (not shown). The force $\vec{F}_1 = 12\hat{i}$. The force $\vec{F}_2$ is always such that velocity of the block at any instant is given by $\vec{v} = \left(12t - 3t^2\right)\hat{i}$. The friction coefficient between block and surface is 0.4.



40. The net force on the block at t = 1sec is

(A) $3\hat{i} + 4\hat{j}$ (B) $12\hat{i}$ (C) $15\hat{i}$ (D) $18\hat{i}$

41. If at t = 1 sec the force $\vec{F}_2$ is acting at 37° angle from positive x-axis, the force of friction on the block at this moment is

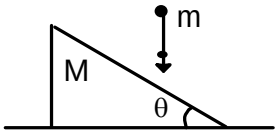
(A) $\frac{102}{13}$ N (B) $\frac{225}{7}$ N (C) $\frac{14}{225}$ N (D) $\frac{7}{225}$ N

42. At $t = t_0$, the magnitude of net force is zero. Then t_0 is

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

PASSAGE FOR QUESTION NOS. 43 – 45

A ball of mass $m = 1\,kg$ is colliding with a wedge of mass $M = 0.9\,kg$ with a velocity of $15\,m/s$ as shown in the figure. After striking the wedge, the ball rebounds in some arbitrary direction and due to the impulse the wedge recoils in backward direction with a speed of $10\,m/s$. Assume all the surfaces to be smooth take $\theta = 37^\circ$ and $g = 10\,m/s^2$.



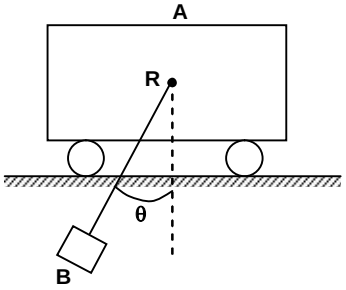
43. Velocity of ball after collision would be
(A) $\sqrt{90}\,m/s$ (B) $10\,m/s$ (C) $5\,m/s$ (D) 14.3 NS

44. The coefficient of restitution between ball and wedge is
(A) 0.5 (B) 0.75 (C) 0.68 (D) 0.4

45. Magnitude of Impulse would be
(A) $18\,N-S$ (B) $110\,N-S$ (C) $8\,N/S$ (D) 15 NS

PARAGRAPH FOR QUESTIONS 46 TO 48

A block B of mass M is suspended from a cord of length ℓ attached to a cart A of mass M as shown in the figure. The horizontal surface on which the cart moves is smooth. Initially both the cart and the block are at rest in the position shown. Now B is released. Take M = 2kg, $\theta = 45^o$ and $g = 10\ m/s^2$.



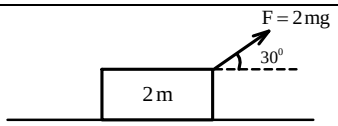
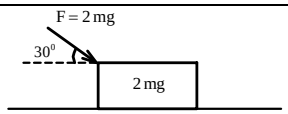
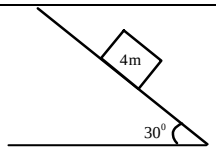
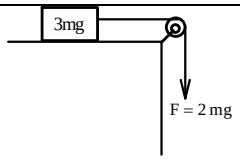
46. The acceleration of the cart immediately after the system is released from rest is
(A) $\frac{1}{\sqrt{2}}\,m/s^2$ (B) $\frac{10}{3}\,m/s^2$ (C) $\frac{10}{3\sqrt{2}}\,m/s^2$ (D) $5\ m/s^2$

47. The tension in the cord immediately after the system is released from rest is
(A) 10 N (B) $\frac{10}{3}\,N$ (C) $\frac{5\sqrt{3}}{2}\,N$ (D) $\frac{20\sqrt{2}}{3}\,N$

48. The magnitude of acceleration of B (with respect to cart) immediately after the system is released from rest is
(A) $\frac{10}{3}[2+\sqrt{2}]$ (B) $\frac{10}{3}[\sqrt{2}+1]$ (C) $\frac{10}{3}[\sqrt{3}+\sqrt{2}]$ (D) $\frac{40}{3\sqrt{2}}$

Match the Column type Question:

49. All the systems in the following question are in equilibrium then match the following column I with column II

Column I	**Column II**
(A) 	(p)Friction force on block can be $\sqrt{3}$mg .
(B) 	(q) Friction force on block can be 2 mg
(C) 	(r) Normal reaction on block can be 3 mg
(D) 	(s) Contact force on block is 4 mg
	(t) Contact force is mg

ANSWER KEY

1.	(d)	2.	(a)	3.	(b)	4.	(c)	5.	(a)	6.	(b)
7.	(d)	8.	(c)	9.	(a)	10.	(b)	11.	(b)	12.	(b)
13.	(b)	14.	(c)	15.	(b)	16.	(c)	17.	(b)	18.	(b)
19.	(b)	20.	(c)	21.	(a,b)	22.	(a,b,c)	23.	(b,d)	24.	(a,b,d)
25.	(a,b,c,d)	26.	(a,b,d)	27.	(a,b,c)	28.	(a,c)	29.	(a,c)	30.	(a,b,d)
31.	(a,c)	32.	(2)	33.	(5)	34.	(8)	35	(7)	36.	(5)
37.	(6)	38.	(0)	39.	(1)	40.	(d)	41.	(a)	42.	(b)
43.	(a)	44.	(b)	45.	(d)	46.	(b)	47.	(d)	48.	(d)

49. (A – p), (B – pr), (C – qs), (D – qrs)