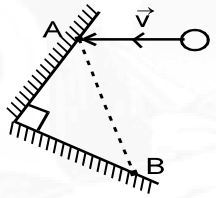
PHYSICS **Max.Marks:80**

SECTION-1
(SINGLE CORRECT CHOICE TYPE)

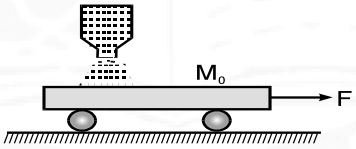
Section-I (Single Correct Answer Type, Total Marks: 24) contains 8 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. For each question you will be awarded 3 marks if you darken ONLY the bubble corresponding to the correct answer and zero marks if no bubble is darkened. In all other cases, minus one (-1) mark will be awarded.

21. AB is an L shaped obstacle fixed on a horizontal smooth table. A ball strikes it at A, gets deflected and restrikes it at B. If the velocity vector before collision $\vec{v}$ is and coefficient of restitution of each collision is 'e', then the velocity of ball after its second collision at B is



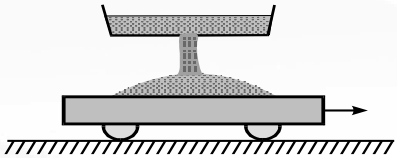
A) $e^2\vec{v}$ B) $-e^2\vec{v}$ C) $-e\vec{v}$ D) data insufficient

22. In the fig. shown a cart moves on a smooth horizontal surface due to an external constant force of magnitude F. The initial mass of the cart is M_0 and velocity is zero. Sand falls on to the cart with negligible velocity at constant rate $\mu\, kg/s$ and sticks to the cart. The velocity of the cart at time t is :



A) $\frac{F\,t}{M_0+\mu t}$ B) $\frac{F\,t}{M_0}e^{\mu t}$ C) $\frac{F\,t}{M_0}$ D) $\frac{F\,t}{M_0+\mu t}e^{\mu t}$

23. Sand is falling on a flat car being pulled with constant speed. The rate of mass falling on the cart is constant. Then the horizontal component of force exerted by the falling sand on the cart

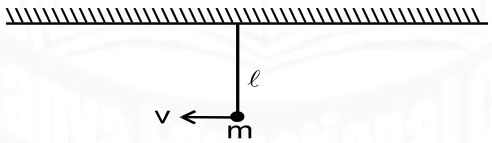


A) increases B) decreases
C) remains constant D) increases and then decreases

24. A particle moving with a velocity $\vec{v} = 2\hat{i} + 3\hat{j} - 4\hat{k}$ strikes a smooth fixed wall placed in x-y plane. Assuming the collision to be inelastic, the velocity of the particle just after the collision may be

A) $2\hat{i} + 3\hat{j} + 3\hat{k}$ B) $2\hat{i} + 3\hat{j} + 4\hat{k}$
C) $2\hat{i} + 3\hat{j} + 5\hat{k}$ D) $2\hat{i} - 3\hat{j} - 4\hat{k}$

25. A simple pendulum (a simple pendulum is a small spherical bob suspended from roof by an inextensible light string as shown in figure) of length ℓ hangs from a horizontal roof as shown in figure. The bob of mass m is given an initial horizontal velocity of magnitude $\sqrt{5g\ell}$ as shown in fig. The coefficient of restitution $e = \frac{1}{2}$. After how many collisions the bob shall no longer come into contact with the horizontal roof.



A) 1 B) 2 C) 4 D) none of these

26. For a two-body system in absence of external forces, the kinetic energy as measured from ground frame is K_0 and from center of mass frame is K_{cm}. Pick up the wrong statement

A) The kinetic energy as measured from center of mass frame is least

B) Only the portion of energy K_{cm} can be transformed from one form to another due to internal changes in the system.

C) The system always retains at least $K_0 - K_{cm}$ amount of kinetic energy as measured from ground frame irrespective of any kind of internal changes in the system.

D) The system always retains at least K_{cm} amount of kinetic energy as measured from ground frame irrespective of any kind of internal changes in the system

27. Three small bodies of identical masses can move along a straight line. The central body (2) is initially at rest and bodies 1 and 3 are at a distance ℓ and 2ℓ from the central body respectively. Bodies 1 and 3 move towards body 2 with speeds v_0 each. The collision between 1 and 2 is perfectly elastic and the collision between body 2 and 3 is perfectly inelastic. After all the collisions are over :

A) all the bodies come to rest

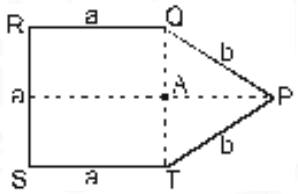
B) the body 1 moves towards left, bodies 2 and 3 move towards right

C) body 2 remains at rest and other bodies 1 and 3 turn back

D) all the bodies move towards right.

28. A homogeneous plate PQRST is as shown in figure. The centre of mass of plate lies at midpoint A of segment QT. Then the ratio of $\frac{b}{a}$ is

(PQ = PT = b; QR = RS = ST = a)



A) $\frac{13}{4}$ B) $\frac{13}{2}$ C) $\sqrt{\frac{13}{2}}$ D) $\sqrt{\frac{13}{4}}$

SECTION-2
(MORE THAN ONE TYPE)

Section - II (Multiple Correct Answers Type, Total Marks: 16) contains 4 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE or MORE may be correct. For each question you will be awarded 4 marks if you darken ALL the bubble(s) corresponding to the correct answer(s) ONLY and zero marks otherwise. There are no negative marks in this section.

29. In each of three figures shown, two blocks are connected by a light spring and the system is placed on smooth horizontal surface. A constant horizontal force of magnitude F is applied to left block as shown. Assuming spring constant in all three cases to be same, which of the following statements is/are true.

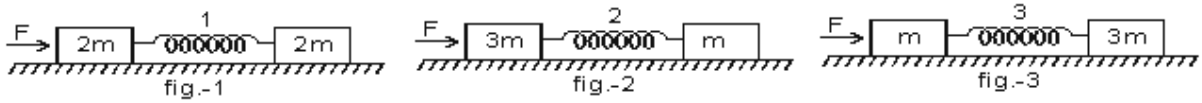


fig.-1 fig.-2 fig.-3

A) maximum compression in spring 1 is greater than that in spring 2.

B) maximum compression in spring 3 is greater than that in spring 1.

C) maximum compression in spring 3 is greater than that in spring 2.

D) maximum compression in all springs is equal.

30. A sphere of mass m moving with speed v collides elastically with a stationary sphere of mass km, where k is some numerical factor. Let their resulting velocities be $\vec{v}_1$ and $\vec{v}_2$ respectively. Then pick up the correct statements :

A) If the collision is oblique $\vec{v}_2$, must be perpendicular to $2\vec{v}_1 + (k-1)\vec{v}_2$.

B) If the collision is oblique $\vec{v}_2$, must be perpendicular to $\vec{v}_1 + (2k-1)\vec{v}_2$

C) If the collision is head-on $\vec{v}_1 = \left(\frac{1-k}{2}\right)\vec{v}_2$,

D) If the collision is head-on $\vec{v}_1 = (1-2k)\vec{v}_2$,

31. Two small spheres of mass m_1 and m_2 are moving towards each other with constant velocities $\vec{u}_1$ and $\vec{u}_2$ respectively and undergo head on inelastic collision. If the coefficient of restitution is e and $m_1\vec{u}_1 + m_2\vec{u}_2 = 0$, then pick up the correct statements.

A) During the collision, least kinetic energy of system of both spheres is zero.

B) Velocity of separation of both spheres after collision has magnitude $= e|\vec{u}_1 - \vec{u}_2|$

C) Velocity of sphere of mass m1 after collision $= -e\vec{u}_1$

D) At the instant of maximum deformation during collision, speed of each sphere is zero.

32. Which of the following statements for a rigid object undergoing pure translational motion are ***false***?

A) If an object receives an impulse its kinetic energy must change.

B) An object's kinetic energy can change without the object receiving any impulse.

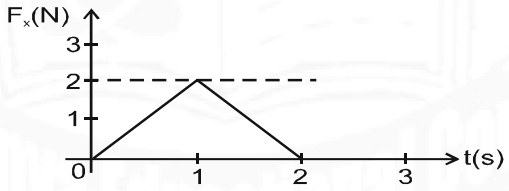
C) An object can receive a net impulse without any work being done on it.

D) A force may do work on an object without delivering any impulse.

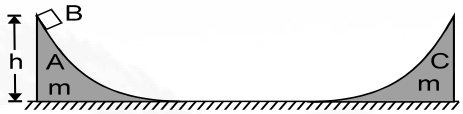
SECTION-3
[INTEGER TYPE]

Section-III (Integer Answer Type, Total Marks: 24) contains 6 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The bubble corresponding to the correct answer is to be darkened in the ORS. For each question you will be awarded 4 marks if you darken ONLY the bubble corresponding to the correct answer and zero marks otherwise. There are no negative marks in this section.

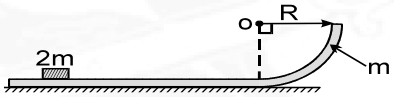
33. The given figure shows a plot of the time dependent force F_x acting on a particle in motion along the x-axis. What is the total impulse (in kg-m/s) delivered by this force to the particle from time t = 0 to t = 2 second?



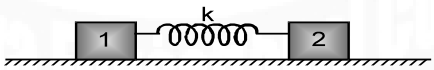
34. In the figure shown a small block B of mass m is released from the top of a smooth movable wedge A of the same mass m. The height of wedge A shown in figure is h = 16 cm. B ascends another movable smooth wedge C of the same mass. Neglecting friction any where find the maximum height (in cm) attained by block B on wedge C.



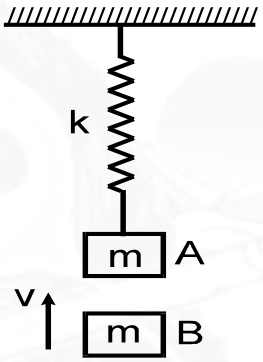
35. Mass 2m is kept on a smooth circular track (R = 9 metres) of mass m which is kept on a smooth horizontal surface. The circular track is given a horizontal velocity $\sqrt{2gR}$ towards left and released. Find the maximum height reached by 2m in metres.



36. Two blocks of masses m_1 and m_2 are connected by spring of constant K such that $\frac{m_2}{m_1} = 9$. The spring is initially compressed and the system is released from rest at t = 0 second. The work done by spring on the blocks m_1 and m_2 be W_1 and W_2 respectively by time t. The speeds of both the blocks at time 't' are non zero. Then find the value of $\frac{W_1}{W_2}$.



37. Block ' A ' of mass m is hanging from a vertical spring of spring constant k and is at rest. The value of $\frac{m}{k} = \frac{1}{150}$ SI units. Block ' B ' also of mass m strikes the block 'A' with velocity ' v ' and sticks to it. Then find the value of ' v ' in m/ s for which the spring just attains natural length. Take $g = 10\ m/s^2$



38 Two skaters A and B, both of mass 70 kg, are approaching one another over a frictionless fixed surface, each with a speed of $1\ m/s$ with respect to the surface. A carries a bowling ball of mass of 10 kg. Both skaters can throw the ball at 5 m/s relative to themselves. To avoid collision they start throwing the ball back and forth when they are 10 m apart. How many minimum number of throws are required ?

SECTION-4
[Matrix Matching Type]

Section-IV (Matrix-Match Type, Total Marks: 16) contains 2 questions. Each question has four statements (A, B, C and D) given in Column I and five statements (p, q, r, s and t) in Column II. Any given statement in Column I can have correct matching with ONE or MORE statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS. For each question you will be awarded 2 marks for each row in which you have darkened ALL the bubble(s) corresponding to the correct answer(s) ONLY and zero marks otherwise. Thus, each question in this section carries a maximum of 8 marks. There are no negative marks in this section.

39. Two identical uniform solid spheres of mass m each approach each other with constant velocities such that net momentum of system of both spheres is zero. The speed of each sphere before collision is u. Both the spheres then collide. The condition of collision is given for each situation of column-I. In each situation of column-II information regarding speed of sphere(s) is given after the collision is over. Match the condition of collision in column-I with statements in column-II.

Column I		Column II	
A)	Collision is perfectly elastic and head on	P)	speed of both spheres after collision is u
B)	Collision is perfectly elastic and oblique	Q)	velocity of both spheres after collision is different
C)	Coefficient of restitution is $e = \frac{1}{2}$ and collision is head on	R)	speed of both spheres after collision is same but less than u.
D)	Coefficient of restitution is $e = \frac{1}{2}$ and collision is oblique	S)	speed of one sphere may be more than u.
		T	

40. Two blocks A and B of mass m and 2m respectively are connected by a massless spring of spring constant K. This system lies over a smooth horizontal surface. At t = 0 the block A has velocity u towards right as shown while the speed of block B is zero, and the length of spring is equal to its natural length at that instant. In each situation of column I, certain statements are given and corresponding results are given in column II. Match the statements in column-I corresponding results in column-II and indicate your answer by darkening appropriate bubbles in the 4 × 4 matrix given in the OMR.

Column I		Column II	
A)	The velocity of block A	P)	can never be zero
B)	The velocity of block B	Q)	may be zero at certain instants of time
C)	The kinetic energy of system of two blocks spring	R)	is minimum at maximum compression of spring
D)	The potential energy of spring	S)	is maximum at maximum extension of spring
		T	