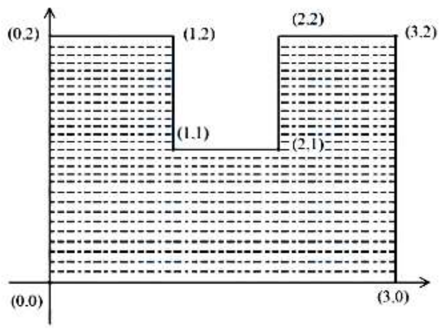
Q1. Three bodies A, B and C have equal kinetic energies and their masses are 400 g. 1.2 kg and 1.6 kg respectively. The ratio of their linear momenta is : ***08 Apr 2024 (M)***

(1) $\sqrt{2}; \sqrt{3}; 1$
(2) $1 : \sqrt{3} : 2$
(3) $1 : \sqrt{3} : \sqrt{2}$
(4) $\sqrt{3} : \sqrt{2} : 1$

Q2. A player caught a cricket ball of mass 150 g moving at a speed of $20 \mathrm{~m/s}$. If the catching process is completed in 0.1 s, the magnitude of force exerted by the ball on the hand of the player is: ***08 Apr 2024 (M)***

(1) $3 \mathrm{~N}$
(2) $300 \mathrm{~N}$
(3) $150 \mathrm{~N}$
(4) $30 \mathrm{~N}$

Q3. A uniform thin metal plate of mass $10 \mathrm{~kg}$ with dimensions is shown. The ratio of x and y coordinates of center of mass of plate in $\frac{n}{9}$. The value of n is _____



08 Apr 2024 (M)

Q4. Four particles A, B, C, D of mass $\frac{m}{2}, m, 2m, 4m$, have same momentum, respectively. The particle with maximum kinetic energy is : ***06 Apr 2024 (M)***

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

Q5. When kinetic energy of a body becomes 36 times of its original value, the percentage increase in the momentum of the body will be: ***06 Apr 2024 (E)***

(1) 6%
(2) 600%
(3) 60%
(4) 500%

Q6. In a system two particles of masses $m_1 = 3$ kg and $m_2 = 2$ kg are placed at certain distance from each other. The particle of mass m_1 is moved towards the center of mass of the system through a distance 2 cm. In order to keep the center of mass of the system at the original position, the particle of mass m_2 should move towards the center of mass by the distance _____ cm. ***04 Apr 2024 (E)***

Q7. The identical spheres each of mass $2M$ are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 4 m each. Taking point of intersection of these two sides as origin, the magnitude of position vector of the centre of mass of the system is $\frac{4\sqrt{2}}{x}$, where the value of x is ________. ***01 Feb 2024 (M)***

Q8. A simple pendulum of length 1 m has a wooden bob of mass 1 kg. It is struck by a bullet of mass 10^{-2} kg moving with a speed of $2 \times 10^2 \mathrm{~m~s}^{-1}$. The bullet gets embedded into the bob. The height to which the bob rises before swinging back is. (use $g = 10 \mathrm{~m~s}^{-2}$) ***01 Feb 2024 (M)***

(1) $0.30 \mathrm{~m}$
(2) $0.20 \mathrm{~m}$
(3) $0.35 \mathrm{~m}$
(4) $0.40 \mathrm{~m}$

Q9. A uniform rod AB of mass 2 kg and Length 30 cm at rest on a smooth horizontal surface. An impulse of force 0.2 N s is applied to end B. The time taken by the rod to turn through at right angles will be $\frac{\pi}{x}$ s, where $x =$ ____. ***01 Feb 2024 (E)***

Q10. A spherical body of mass 100 g is dropped from a height of 10 m from the ground. After hitting the ground, the body rebounds to a height of 5 m. The impulse of force imparted by the ground to the body is given by: (given $g=9.8 \mathrm{~m} \mathrm{~s}^{-2}$) ***30 Jan 2024 (M)***

(1) $4.32 \mathrm{~kg} \mathrm{~m} \mathrm{~s}^{-1}$
(2) $43.2 \mathrm{~kg} \mathrm{~m} \mathrm{~s}^{-1}$
(3) $23.9 \mathrm{~kg} \mathrm{~m} \mathrm{~s}^{-1}$
(4) $2.39 \mathrm{~kg} \mathrm{~m} \mathrm{~s}^{-1}$

Q11. A body of mass $1000 \mathrm{~kg}$ is moving horizontally with a velocity $6 \mathrm{~m} \mathrm{~s}^{-1}$. If $200 \mathrm{~kg}$ extra mass is added, the final velocity (in $\mathrm{m} \mathrm{~s}^{-1}$) is: ***27 Jan 2024 (M)***

(1) 6
(2) 2
(3) 3
(4) 5

Q12. Two bodies are having kinetic energies in the ratio 16 : 9. If they have same linear momentum, the ratio of their masses respectively is:

13 Apr 2023 (M)

(1) 3 : 4
(2) 9 : 16
(3) 16 : 9
(4) 4 : 3

Q13. A bullet of 10 g leaves the barrel of gun with a velocity of $600 \mathrm{~m} \mathrm{~s}^{-1}$. If the barrel of gun is $50 \mathrm{~cm}$ long and mass of gun is $3 \mathrm{~kg}$, then value of impulse supplied to the gun will be:

13 Apr 2023 (M)

(1) 6 N s
(2) 3 N s
(3) 36 N s
(4) 12 N s

Q14. An average force of 125 N is applied on a machine gun firing bullets each of mass 10 g at the speed of $250 \mathrm{~m} \mathrm{~s}^{-1}$ to keep it in position. The number of bullets fired per second by the machine gun is :

11 Apr 2023 (M)

(1) 50
(2) 25
(3) 100
(4) 5

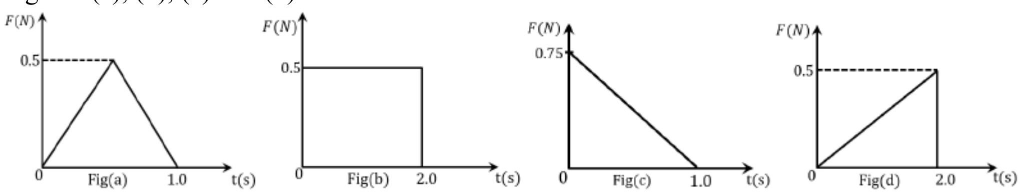
Q15. A nucleus disintegrates into two nuclear parts, in such a way that ratio of their nuclear sizes is $1 : 2^{1/3}$. Their respective speed have a ratio of $n : 1$. The value of n is_________ ***11 Apr 2023 (E)***

Q16. A particle of mass m moving with velocity v collides with a stationary particle of mass $2m$. After collision, they stick together and continue to move together with velocity ***10 Apr 2023 (M)***

(1) $\frac{v}{3}$
(2) $\frac{v}{4}$
(3) v
(4) $\frac{v}{2}$

Q17. The momentum of a body is increased by 50%. The percentage increase in the kinetic energy of the body is_ _______%. ***08 Apr 2023 (M)***

Q18. Figures (a), (b), (c) and (d) show variation of force with time.



The impulse is highest in figure.

01 Feb 2023 (E)

(1) Fig (c)
(2) Fig (b)
(3) Fig (a)
(4) Fig (d)

Q19. 100 balls each of mass m moving with speed v simultaneously strike a wall normally and reflected back with same speed, in time t s. The total force exerted by the balls on the wall is ***31 Jan 2023 (M)***

(1) $\frac{100mv}{t}$ (2) $\frac{200mv}{t}$

(3) $200\ mvt$ (4) $\frac{mv}{100t}$

Q20. A ball is dropped from a height of $20\ \mathrm{m}$. If the coefficient of restitution for the collision between ball and floor is 0.5, after hitting the floor, the ball rebounds to a height of ______ m. ***31 Jan 2023 (E)***

Q21. A machine gun of mass $10\ \mathrm{kg}$ fires $20\ \mathrm{g}$ bullets at the rate of 180 bullets per minute with a speed of $100\ \mathrm{m\ s^{-1}}$ each. The recoil velocity of the gun is : ***30 Jan 2023 (E)***

(1) $0.02\ \mathrm{m\ s^{-1}}$ (2) $2.5\ \mathrm{m\ s^{-1}}$

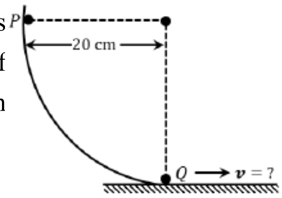
(3) $1.5\ \mathrm{m\ s^{-1}}$ (4) $0.6\ \mathrm{m\ s^{-1}}$

Q22. A ball of mass $200\ \mathrm{g}$ rests on a vertical post of height $20\ \mathrm{m}$. A bullet of mass $10\ \mathrm{g}$, travelling in horizontal direction, hits the centre of the ball. After collision both travels independently. The ball hits the ground at a distance $30\ \mathrm{m}$ and the bullet at a distance of $120\ \mathrm{m}$ from the foot of the post. The value of initial velocity of the bullet will be (if $g = 10\ \mathrm{m\ s^{-2}}$) : ***30 Jan 2023 (M)***

(1) $120\ \mathrm{m\ s^{-1}}$ (2) $60\ \mathrm{m\ s^{-1}}$

(3) $400\ \mathrm{m\ s^{-1}}$ (4) $360\ \mathrm{m\ s^{-1}}$

Q23. As per the given figure, a small ball P slides down the quadrant of a circle and hits the other ball Q of equal mass which is initially at rest. Neglecting the effect of friction and assume the collision to be elastic, the velocity of ball Q after collision will be : $\left(g = 10\ \mathrm{m\ s^{-2}}\right)$



30 Jan 2023 (M)

(1) 0 (2) $0.25\ \mathrm{m\ s^{-1}}$

(3) $2\ \mathrm{m\ s^{-1}}$ (4) $4\ \mathrm{m\ s^{-1}}$

Q24. A body of mass $1\ \mathrm{kg}$ collides head on elastically with a stationary body of mass $3\ \mathrm{kg}$. After collision, the smaller body reverses its direction of motion and moves with a speed of $2\ \mathrm{m\ s^{-1}}$. The initial speed of the smaller body before collision is ______ $\mathrm{m\ s^{-1}}$. ***25 Jan 2023 (E)***

Q25. A nucleus disintegrates into two smaller parts, which have their velocities in the ratio 3 : 2. The ratio of their nuclear sizes will be $\left(\frac{x}{3}\right)^{\frac{1}{3}}$. The value of '$x$' is: ***25 Jan 2023 (E)***

Q26. Two bodies of mass $1\ \mathrm{kg}$ and $3\ \mathrm{kg}$ have position vectors $\hat{\mathrm{i}} + 2\hat{\mathrm{j}} + \widehat{\mathrm{k}}$ and $-3\hat{\mathrm{i}} - 2\hat{\mathrm{j}} + \widehat{\mathrm{k}}$ respectively. The magnitude of position vector of centre of mass of this system will be similar to the magnitude of vector : ***29 Jul 2022 (M)***

(1) $\hat{\mathrm{i}} - 2\hat{\mathrm{j}} + \widehat{\mathrm{k}}$ (2) $-3\hat{\mathrm{i}} - 2\hat{\mathrm{j}} + \widehat{\mathrm{k}}$

(3) $-2\hat{\mathrm{i}} + 2\widehat{\mathrm{k}}$ (4) $-2\hat{\mathrm{i}} - \hat{\mathrm{j}} + 2\widehat{\mathrm{k}}$

Q27. If momentum of a body is increased by 20%, then its kinetic energy increases by : ***29 Jul 2022 (E)***

(1) 36% (2) 40%

(3) 44% (4) 48%

Q28. In two different experiments, an object of mass $5\ \mathrm{kg}$ moving with a speed of $25\ \mathrm{ms^{-1}}$ hits two different walls and comes to rest within

(i) 3 second, (ii) 5 seconds, respectively.

Choose the correct option out of the following : ***28 Jul 2022 (M)***

(1) Impulse and average force acting on the object will be same for both the cases.
(2) Impulse will be same for both the cases but the average force will be different.
(3) Average force will be same for both the cases but the impulse will be different.
(4) Average force and impulse will be different for both the cases.

Q29. The distance of centre of mass from end A of a one dimensional rod (AB) having mass density $\rho=\rho_0\left(1-\frac{x^2}{L^2}\right)$ kg m^{-1} and length L (in meter) is $\frac{3L}{\alpha}$ m. The value of α is _____ (where x is the distance form end A) ***28 Jul 2022 (E)***

Q30. A body of mass 8 kg and another of mass 2 kg are moving with equal kinetic energy. The ratio of their respective momenta will be ***26 Jul 2022 (E)***

(1) 1 : 1 (2) 2 : 1
(3) 1 : 4 (4) 4 : 1

Q31. A ball of mass 0.15 kg hits the wall with its initial speed of 12 m s^{-1} and bounces back without changing its initial speed. If the force applied by the wall on the ball during the contact is 100 N. calculate the time duration of the contact of ball with the wall. ***26 Jul 2022 (E)***

(1) 0.018 s (2) 0.036 s
(3) 0.009 s (4) 0.072 s

Q32. Two billiard balls of mass 0.05 kg each moving in opposite directions with 10 ms^{-1} collide and rebound with the same speed. If the time duration of contact is $t=0.005$ s, then what is the force exerted on the ball due to each other? ***25 Jul 2022 (E)***

(1) 100 N (2) 200 N
(3) 300 N (4) 400 N

Q33. Three identical spheres each of mass M are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 3 m each. Taking point of intersection of mutually perpendicular sides as origin, the magnitude of position vector of centre of mass of the system will be $\sqrt{x}$ m. The value of x is ***25 Jul 2022 (E)***

Q34. A body of mass M at rest explodes into three pieces, in the ratio of masses 1 : 1 : 2. Two smaller pieces fly off perpendicular to each other with velocities of 30 m s^{-1} and 40 m s^{-1} respectively. The velocity of the third piece will be ***29 Jun 2022 (M)***

(1) 35 m s^{-1} (2) 50 m s^{-1}
(3) 25 m s^{-1} (4) 15 m s^{-1}

Q35. A man of 60 kg is running on the road and suddenly jumps into a stationary trolly car of mass 120 kg. Then the trolly car starts moving with velocity 2 m s^{-1}. The velocity of the running man was _____ m s^{-1}, when he jumps into the car. ***28 Jun 2022 (M)***

Q36. Two blocks of masses 10 kg and 30 kg are placed on the same straight line with coordinates $(0,0)$ cm and $(x,0)$ cm respectively. The block of 10 kg is moved on the same line through a distance of 6 cm towards the other block. The distance through which the block of 30 kg must be moved to keep the position of centre of mass of the system unchanged is ***27 Jun 2022 (M)***

(1) 4 cm towards the 10 kg block (2) 2 cm away from the 10 kg block
(3) 2 cm towards the 10 kg block (4) 4 cm away from the 10 kg block

Q37. What percentage of kinetic energy of a moving particle is transferred to a stationary particle when it strikes the stationary particle of 5 times its mass?

(Assume the collision to be head-on elastic collision) ***27 Jun 2022 (M)***

(1) 50.0% (2) 66.6%

(3) 55.6% (4) 33.3%

Q38. A pendulum of length $2\ \mathrm{m}$ consists of a wooden bob of mass $50\ \mathrm{g}$. A bullet of mass $75\ \mathrm{g}$ is fired towards the stationary bob with a speed v. The bullet emerges out of the bob with a speed $\frac{v}{3}$ and the bob just completes the vertical circle. The value of v is _____ $\mathrm{m\ s^{-1}}$
(if $g = 10\ \mathrm{m\ s^{-2}}$).

27 Jun 2022 (M)

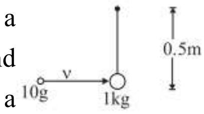
Q39. A batsman hits back a ball of mass 0.4 kg straight in the direction of the bowler without changing its initial speed of $15\ \mathrm{m\ s^{-1}}$. The impulse imparted to the ball is _____ N s. ***26 Jun 2022 (E)***

Q40. A body of mass M moving at speed V_0 collides elastically with a mass m at rest. After the collision, the two masses move at angles θ_1 and θ_2 with respect to the initial direction of motion of the body of mass M.. The largest possible value of the ratio $\frac{M}{m}$, for which the angles θ_1 and θ_2 will be equal, is : ***31 Aug 2021 (M)***

(1) 3 (2) 4

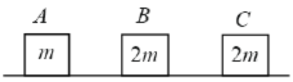
(3) 2 (4) 1

Q41. A bullet of $10\ \mathrm{g}$, moving with velocity v, collides head-on with the stationary bob of a pendulum and recoils with velocity $100\ \mathrm{m\ s^{-1}}$. The length of the pendulum is $0.5\ \mathrm{m}$ and mass of the bob is 1 kg. The minimum value of v in $\mathrm{m\ s^{-1}}$, so that the pendulum describes a circle. (Assume the string to be inextensible and $\mathrm{g} = 10\ \mathrm{m\ s^{-2}}$)



27 Aug 2021 (E)

Q42. Three objects A, B and C are kept in a straight line on a frictionless horizontal surface. The masses of A, B and C are m, $2m$ and $2m$ respectively. A moves towards B with a speed of $9\ \mathrm{m\ s^{-1}}$ and makes an elastic collision with it. Thereafter B makes a completely inelastic collision with C. All motions occur along the same straight line. The final speed of C is :



27 Jul 2021 (M)

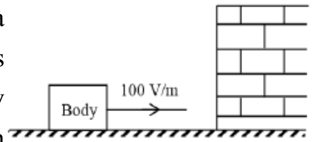
(1) $6\ \mathrm{m\ s^{-1}}$ (2) $9\ \mathrm{m\ s^{-1}}$

(3) $4\ \mathrm{m\ s^{-1}}$ (4) $3\ \mathrm{m\ s^{-1}}$

Q43. A body of mass 2 kg moving with a speed of $4\ \mathrm{m\ s^{-1}}$ makes an elastic collision with another body at rest and continues to move in the original direction but with one fourth of its initial speed. The speed of the two body centre of mass is $x/10$. Find the value of x. ***25 Jul 2021 (M)***

Q44. The position of the centre of mass of a uniform semi-circular wire of radius R placed in $x - y$ plane with its centre at the origin and the line joining its ends as $x-$axis is given by, $\left(0,\ \frac{xR}{\pi}\right)$. Then, the value of $|x|$ is _____.
22 Jul 2021 (M)

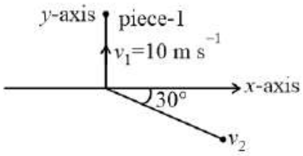
Q45. A body having specific charge $8\ \mu\mathrm{C\ g^{-1}}$ is resting on a frictionless plane at a distance 10 cm from the wall (as shown in the figure). It starts moving towards the wall when a uniform electric field of $100\ \mathrm{V\ m^{-1}}$ is applied horizontally towards the wall. If the collision of the body with the wall is perfectly elastic, then the time period of the motion will be ____s.



20 Jul 2021 (M)

Q46. A rod of mass M and length L is lying on a horizontal frictionless surface. A particle of mass m travelling along the surface hits at one end of the rod with a velocity u in a direction perpendicular to the rod. The collision is completely elastic. After collision, particle comes to rest. The ratio of masses $\left(\frac{m}{M}\right)$ is $\frac{1}{x}$. The value of x will be ***20 Jul 2021 (M)***

Q47. A ball of mass $10\ \text{kg}$ moving with a velocity $10\sqrt{3}\ \text{m s}^{-1}$ along the x -axis, hits another ball of mass $20\ \text{kg}$ which is at rest. After the collision, first ball comes to rest while the second ball disintegrates into two equal pieces. One piece starts moving along y -axis with a speed of $10\ \text{m s}^{-1}$. The second piece starts moving at an angle of 30° with respect to the x -axis. The velocity of the ball moving at 30° with x -axis is $x\ \text{m s}^{-1}$. The configuration of pieces after the collision is shown in the figure below. The value of x to the nearest integer is

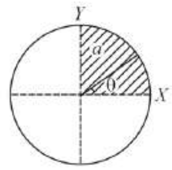


18 Mar 2021 (M)

Q48. An object of mass m_1 collides with another object of mass m_2, which is at rest. After the collision the objects move with equal speeds in opposite direction. The ratio of the masses $m_2 : m_1$ is : ***18 Mar 2021 (E)***

(1) 3 : 1 (2) 2 : 1
(3) 1 : 2 (4) 1 : 1

Q49. The disc of mass M with uniform surface mass density σ is shown in the figure. The center of mass of the quarter disc (the shaded area) is at the position $\left(\frac{xa}{3\pi}, \frac{xa}{3\pi}\right)$ where x is _____. (Round off to the Nearest Integer) [a is an area as shown in the figure]

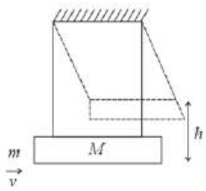


17 Mar 2021 (E)

Q50. A rubber ball is released from a height of $5\ \text{m}$ above the floor. It bounces back repeatedly, always rising to $\frac{81}{100}$ of the height through which it falls. Find the average speed of the ball. (Take $g = 10\ \text{m s}^{-2}$) ***17 Mar 2021 (E)***

(1) $3.0\ \text{m s}^{-1}$ (2) $3.5\ \text{m s}^{-1}$
(3) $2.0\ \text{m s}^{-1}$ (4) $2.50\ \text{m s}^{-1}$

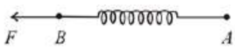
Q51. A large block of wood of mass $M = 5.99\ \text{kg}$ is hanging from two long massless cords. A bullet of mass $m = 10\ \text{g}$ is fired into the block and gets embedded in it. The (block + bullet) then swing upwards, their center of mass rising a vertical distance $h = 9.8\ \text{cm}$ before the (block + bullet) pendulum comes momentarily to rest at the end of its arc. The speed of the bullet just before the collision is: (Take $g = 9.8\ \text{m s}^{-2}$)



16 Mar 2021 (E)

(1) $841.4\ \text{m s}^{-1}$ (2) $811.4\ \text{m s}^{-1}$
(3) $831.4\ \text{m s}^{-1}$ (4) $821.4\ \text{m s}^{-1}$

Q52. Two masses A and B, each of mass M are fixed together by a massless spring, A force acts on the mass B as shown in figure. If the mass A starts moving away from mass B with acceleration a, then the acceleration of mass B will be :



26 Feb 2021 (E)

(1) $\frac{MF}{F+Ma}$ (2) $\frac{F+Ma}{M}$
(3) $\frac{Ma-F}{M}$ (4) $\frac{F-Ma}{M}$

Q53. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Body P having mass M moving with speed u has head-on collision elastically with another body Q having mass m initially at rest. If $m \ll M$, body Q will have a maximum speed equal to $2u$ after collision.

Reason R : During elastic collision, the momentum and kinetic energy are both conserved.

In the light of the above statements, choose the most appropriate answer from the options given below:

26 Feb 2021 (M)

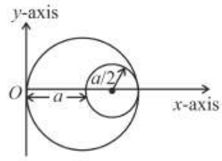
(1) A is correct but R is not correct.

(2) A is not correct but R is correct.

(3) Both A and R are correct and R is the correct explanation of A

(4) Both A and R are correct but R is NOT the correct explanation of A

Q54. A circular hole of radius $\left(\frac{a}{2}\right)$ is cut out of a circular disc of radius a as shown in figure. The centroid of the remaining circular portion with respect to point O will be:



24 Feb 2021 (E)

(1) $\frac{2}{3}a$ (2) $\frac{5}{6}a$

(3) $\frac{1}{6}a$ (4) $\frac{10}{11}a$

Q55. A ball with a speed of $9 \mathrm{~m~s}^{-1}$ collides with another identical ball at rest. After the collision, the direction of each ball makes an angle of 30° with the original direction. If the ratio of velocities of the balls after the collision is $x : y$, then what is the value of x? ***24 Feb 2021 (M)***

Q56. The centre of mass of a solid hemisphere of radius $8 \mathrm{~cm}$ is $\mathrm{x} \mathrm{~cm}$ from the centre of the flat surface. Then value of x is ***06 Sep 2020 (E)***

Q57. Two bodies of the same mass are moving with the same speed, but in different directions in a plane. They have a completely inelastic collision and move together thereafter with a final speed which is half of their initial velocities of the two bodies (in degree) is - ***06 Sep 2020 (M)***

Q58. Particle A of mass m_1 moving with velocity $\left(\sqrt{3}\hat{\mathrm{i}}+\hat{\mathrm{j}}\right) \mathrm{ms}^{-1}$ collides with another particle B of mass m_2 which is at rest initially. Let $\overrightarrow{\mathrm{v}_1}$ and $\overrightarrow{\mathrm{v}_2}$ be the velocities of particles A and B after collision respectively. If $\mathrm{m}_1 = 2\mathrm{m}_2$ and after collision $\overrightarrow{\mathrm{v}_1} - \left(\hat{\mathrm{i}}+\sqrt{3}\hat{\mathrm{j}}\right) \mathrm{ms}^{-1}$, the angle between $\overrightarrow{\mathrm{v}_1}$ and $\overrightarrow{\mathrm{v}_2}$ is : ***06 Sep 2020 (E)***

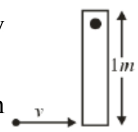
(1) 15° (2) 60°

(3) -45° (4) 105°

Q59. A particle of mass $200 \mathrm{~MeV~c}^{-2}$ collides with a hydrogen atom at rest. Soon after the collision, the particle comes to rest, and the atom recoils and goes to its first excited state. The initial kinetic energy of the particle (in eV) is $\frac{N}{4}$. The value of N is: (Given the mass of the hydrogen atom to be $1 \mathrm{~GeV~c}^{-2}$).........

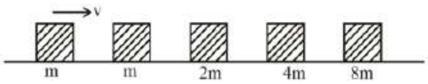
05 Sep 2020 (M)

Q60. A thin rod of mass $0.9 \mathrm{~kg}$ and length $1 \mathrm{~m}$ is suspended, at rest, from one end so that it can freely oscillate in the vertical plane. A particle of move $0.1 \mathrm{~kg}$ moving in a straight line with velocity $80 \mathrm{~m~s}^{-1}$ hits the rod at its bottom most point and sticks to it (see figure). The angular speed (in $\mathrm{rad~s}^{-1}$) of the rod immediately after the collision will be ....



05 Sep 2020 (E)

Q61. Blocks of masses $\mathrm{m}, 2\mathrm{m}, 4\mathrm{m}$ and $8\mathrm{m}$ are arranged in a line of a frictionless floor. Another block of mass m , moving with speed v along the same line (see figure) collides with mass m in perfectly inelastic manner. All the subsequent collisions are also perfectly inelastic. By the time the last block of mass $8\mathrm{m}$ starts moving the total energy loss is $\mathrm{p}\%$ of the original energy. Value of 'p ' is close to:



04 Sep 2020 (M)

(1) 77 (2) 94
(3) 37 (4) 87

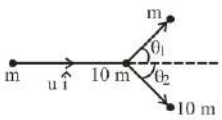
Q62. A block of mass 1.9 kg is at rest at the edge of a table, of height 1 m. A bullet of mass 0.1 kg collides with the block and sticks to it. If the velocity of the bullet is $20 \mathrm{~m~s^{-1}}$ in the horizontal direction just before the collision then the kinetic energy just before the combined system strikes the floor, is [Take $\mathrm{g} = 10 \mathrm{~m~s^{-2}}$. Assume there is no rotational motion and loss of energy after the collision is negligible.] ***03 Sep 2020 (E)***

(1) 21 J (2) 20 J
(3) 19 J (4) 23 J

Q63. A particle of mass m with an initial velocity $\mathrm{u}\hat{i}$ collides perfectly elastically with a mass $3 \mathrm{~m}$ at rest. It moves with a velocity $\mathrm{v}\hat{j}$ after collision, then, v is given by ***02 Sep 2020 (M)***

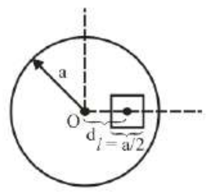
(1) $\mathrm{v} = \sqrt{\frac{2}{3}}\mathrm{u}$ (2) $\mathrm{v} = \frac{\mathrm{u}}{\sqrt{3}}$
(3) $\mathrm{v} = \frac{\mathrm{u}}{\sqrt{2}}$ (4) $\mathrm{v} = \frac{1}{\sqrt{6}}\mathrm{u}$

Q64. A particle of mass m is moving along the x-axis with initial velocity $\mathrm{u}\hat{\mathrm{i}}$. It collides elastically with a particle of mass $10\mathrm{m}$ at rest and then moves with half its initial kinetic energy (see figure). If $\sin \theta_1 = \sqrt{\mathrm{n}} \sin \theta_2$ then value of n is ________.



02 Sep 2020 (E)

Q65. A square shaped hole of side $l = \frac{\mathrm{a}}{2}$ is carved out at a distance $\mathrm{d} = \frac{\mathrm{a}}{2}$ from the centre 'O' of a uniform circular disk of radius a. If the distance of the centre of mass of the remaining portion from O is $-\frac{\mathrm{a}}{\mathrm{x}}$, value of X (to the nearest integer) is :



02 Sep 2020 (E)

Q66. A rod of length l has non-uniform linear mass density given by $\rho(x) = a + b\left(\frac{x}{l}\right)^2$, where a and b are constants and $0 \leq x \leq l$ The value of x for the centre of mass of the rod is at: ***09 Jan 2020 (E)***

(1) $\frac{3}{2}\left(\frac{a+b}{2a+b}\right)L$ (2) $\frac{3}{4}\left(\frac{2a+b}{3a+b}\right)L$
(3) $\frac{4}{3}\left(\frac{a+b}{2a+3b}\right)L$ (4) $\frac{3}{2}\left(\frac{2a+b}{3a+b}\right)L$

Q67. Two particles of equal mass m have respective initial velocities $u\hat{i}$ and $u\left(\frac{\hat{i}+\hat{j}}{2}\right)$. They collide completely inelastically. The energy lost in the process is: ***09 Jan 2020 (M)***

(1) $\frac{1}{3}mu^2$ (2) $\frac{1}{8}mu^2$
(3) $\frac{3}{4}mu^2$ (4) $\sqrt{\frac{2}{3}}mu^2$

Q68. A particle of mass m is projected with a speed u from the ground at an angle $\theta = \frac{\pi}{3}$ w.r.t. horizontal (x-axis). When it has reached its maximum height, it collides completely inelastically with another particle of the same mass and velocity $u\hat{i}$. The horizontal distance covered by the combined mass before reaching the ground is:
09 Jan 2020 (E)

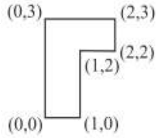
(1) $\frac{3\sqrt{3}}{8}\frac{u^2}{g}$ (2) $\frac{3\sqrt{2}}{4}\frac{u^2}{g}$
(3) $\frac{5}{8}\frac{u^2}{g}$ (4) $2\sqrt{2}\frac{u^2}{g}$

Q69. Consider a uniform rod of mass $M = 4\mathrm{m}$ and length l pivoted about its centre. A mass m moving with velocity v making angle $\theta = \frac{\pi}{4}$ to the rod's long axis collides with one end of the rod and sticks to it. The angular speed of the rod-mass system just after the collision is: ***08 Jan 2020 (M)***

(1) $\frac{3}{7\sqrt{2}} \frac{v}{l}$ (2) $\frac{3}{7} \frac{v}{l}$

(3) $\frac{3\sqrt{2}}{7} \frac{v}{l}$ (4) $\frac{4}{7} \frac{v}{l}$

Q70. The coordinates of the centre of mass of a uniform flag-shaped lamina (thin flat plate) of mass 4 kg. (The coordinates of the same are shown in the figure) are:

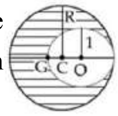


08 Jan 2020 (M)

(1) $(1.25 \mathrm{~m}, 1.50 \mathrm{~m})$ (2) $(0.75 \mathrm{~m}, 1.75 \mathrm{~m})$

(3) $(0.75 \mathrm{~m}, 0.75 \mathrm{~m})$ (4) $(1 \mathrm{~m}, 1.75 \mathrm{~m})$

Q71. As shown in figure. When a spherical cavity (centred at O) of radius 1 is cut out of a uniform sphere of radius R (centred at C), the centre of mass of remaining (shaded part of sphere is at G, i.e., on the surface of the cavity. R can be determined by the equation:



08 Jan 2020 (E)

(1) $\left(R^2+R+1\right)(2-R)=1$ (2) $\left(R^2-R-1\right)(2-R)=1$

(3) $\left(R^2-R+1\right)(2-R)=1$ (4) $\left(R^2+R-1\right)(2-R)=1$

Q72. A body A of mass $m=0.1$ kg has an initial velocity of $3\hat{\mathrm{i}} \mathrm{~m} \mathrm{~s}^{-1}$. It collides elastically with another body B of the same mass which has an initial velocity of $5\hat{\mathrm{j}} \mathrm{~m} \mathrm{~s}^{-1}$. After the collision, A moves with a velocity $\vec{v}=4(\hat{\mathrm{i}}+\hat{\mathrm{j}}) \mathrm{~m} \mathrm{~s}^{-1}$. The energy of B after the collision is written as $\frac{x}{10}$ J. The value of x is ***08 Jan 2020 (M)***

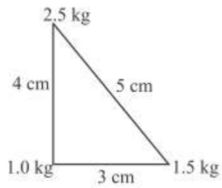
Q73. A particle of mass m is dropped from a height h above the ground. At the same time another particle of the same mass is thrown vertically upwards from the ground with a speed of $\sqrt{2gh}$. If they collide head-on completely inelastically, the time taken for the combined mass to reach the ground, in units of $\sqrt{\frac{h}{g}}$ is:

08 Jan 2020 (E)

(1) $\sqrt{\frac{1}{2}}$ (2) $\sqrt{\frac{3}{4}}$

(3) $\frac{1}{2}$ (4) $\sqrt{\frac{3}{2}}$

Q74. Three point particles of masses 1.0 kg, 1.5 kg and 2.5 kg are placed at three corners of a right angle triangle of sides 4.0 cm, 3.0 cm and 5.0 cm as shown in the figure. The centre of mass of the system is at a point:



07 Jan 2020 (M)

(1) 0.6 cm right and 2.0 cm above 1 kg mass. (2) 1.5 cm right and 1.2 cm above 1 kg mass.

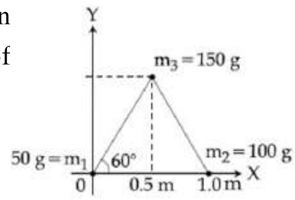
(3) 2.0 cm right and 0.9 cm above 1 kg mass. (4) 0.9 cm right and 2.0 cm above 1 kg mass.

Q75. A man (mass $=50$ kg) and his son (mass $=20$ kg) are standing on a frictionless surface facing each other. The man pushes his son so that he starts moving at a speed of $0.70 \mathrm{~m} \mathrm{~s}^{-1}$ with respect to the man. The speed of the man with respect to the surface is: ***12 Apr 2019 (M)***

(1) $0.20 \mathrm{~m} \mathrm{~s}^{-1}$ (2) $0.14 \mathrm{~m} \mathrm{~s}^{-1}$

(3) $0.47 \mathrm{~m} \mathrm{~s}^{-1}$ (4) $0.28 \mathrm{~m} \mathrm{~s}^{-1}$

Q76. Three particles of masses 50 g, 100 g and 150 g are placed at the vertices of an equilateral triangle of side 1 m (as shown in the figure). The (x, y) coordinates of the centre of mass will be:

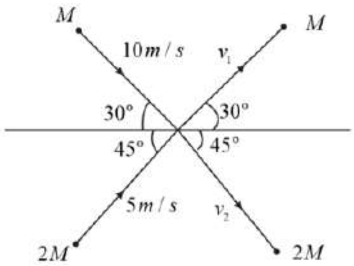


12 Apr 2019 (E)

(1) $\left(\frac{7}{12}\text{ m}, \frac{\sqrt{3}}{4}\text{ m}\right)$ (2) $\left(\frac{7}{12}\text{ m}, \frac{\sqrt{3}}{8}\text{ m}\right)$

(3) $\left(\frac{\sqrt{3}}{4}\text{ m}, \frac{5}{12}\text{ m}\right)$ (4) $\left(\frac{\sqrt{3}}{8}\text{ m}, \frac{7}{12}\text{ m}\right)$

Q77. Two particles of masses M and 2M are moving with speeds of 10 m s^{-1} and 5 m s^{-1}, as shown in the figure. They collide at the origin and after that they move along the indicated directions with speeds v_1 and v_2, respectively. The values of v_1 and v_2 are, nearly



10 Apr 2019 (M)

(1) 6.5 m s^{-1} and 3.2 m s^{-1} (2) 3.2 m s^{-1} and 12.6 m s^{-1}

(3) 13.02 m s^{-1} and 19.7 m s^{-1} (4) 3.2 m s^{-1} and 6.3 m s^{-1}

Q78. A particle of mass m is moving with speed 2v and collides with a mass $2m$ moving with speed v in the same direction. After the collision, the first mass is stopped completely while the second one splits into two particles each of mass m, which move at an angle 45° with respect to the original direction. The speed of each of the moving particle will be ***09 Apr 2019 (E)***

(1) $\sqrt{2}$v (2) $\frac{\text{v}}{\sqrt{2}}$

(3) $2\sqrt{2}$v (4) $\frac{\text{v}}{(2\sqrt{2})}$

Q79. A body of mass 2 kg makes an elastic collision with a second body at rest and continues to move in the original direction but with one fourth of its original speed. What is the mass of the second body?

09 Apr 2019 (M)

(1) 1.8 kg (2) 1.2 kg

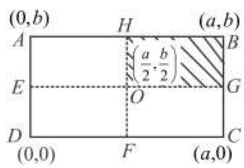
(3) 1.0 kg (4) 1.5 kg

Q80. A body of mass m_1 moving with an unknown velocity of $v_1\,\hat{\text{i}}$, undergoes a collinear collision with a body of mass m_2 moving with a velocity $v_2\,\hat{\text{i}}$. After the collision, m_1 and m_2 move with velocities of $v_3\,\hat{\text{i}}$ and $v_4\,\hat{\text{i}}$, respectively. If $m_2 = 0.5\,m_1$ and $v_3 = 0.5\,v_1$, then v_1 is: ***08 Apr 2019 (E)***

(1) $v_4 - \frac{v_2}{4}$ (2) $v_4 - \frac{v_2}{2}$

(3) $v_4 + v_2$ (4) $v_4 - v_2$

Q81. A uniform rectangular thin sheet $ABCD$ of mass M has length a and breadth b, as shown in the figure. If the shaded portion $HBGO$ is cut-off, the coordinates of the centre of mass of the remaining portion will be:

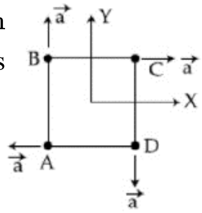


08 Apr 2019 (E)

(1) $\frac{5\text{a}}{12}, \frac{5\text{b}}{12}$ (2) $\frac{5\text{a}}{3}, \frac{5\text{b}}{3}$

(3) $\frac{2\text{a}}{3}, \frac{2\text{b}}{3}$ (4) $\frac{3\text{a}}{4}, \frac{3\text{b}}{4}$

Q82. Four particles A, B, C and D with masses $\mathrm{m_A = m, m_B = 2m, m_C = 3m}$ and $\mathrm{m_D = 4m}$ are at the corners of a square. They have accelerations of equal magnitude with directions as shown. The acceleration of the centre of mass of the particles is:



08 Apr 2019 (M)

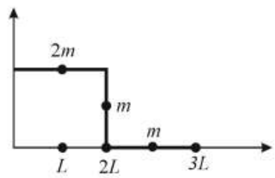
(1) $\frac{a}{5}(\hat{i}+\hat{j})$ (2) $\frac{a}{5}(\hat{i}-\hat{j})$
(3) $a(\hat{i}+\hat{j})$ (4) Zero

Q83. If 10^{22} gas molecules each of mass 10^{-26} kg collides with a surface (perpendicular to it) elastically per second over an area $1\ \mathrm{m}^2$ with a speed $10^4 \mathrm{m/s}$, the pressure exerted by the gas molecules will be of the order of:

08 Apr 2019 (M)

(1) $2\ \mathrm{Pa}$ (2) $4\ \mathrm{Pa}$
(3) $6\ \mathrm{Pa}$ (4) $8\ \mathrm{Pa}$

Q84. The position vector of the center of mass $\overrightarrow{r_{cm}}$ of an asymmetric uniform bar of negligible area of cross-section as shown in figure is:



12 Jan 2019 (M)

(1) $\overrightarrow{r_{cm}} = \frac{13}{8}L\hat{x} + \frac{5}{8}L\hat{y}$ (2) $\overrightarrow{r_{cm}} = \frac{5}{8}L\hat{x} + \frac{13}{8}L\hat{y}$
(3) $\overrightarrow{r_{cm}} = \frac{3}{8}L\hat{x} + \frac{11}{8}L\hat{y}$ (4) $\overrightarrow{r_{cm}} = \frac{11}{8}L\hat{x} + \frac{3}{8}L\hat{y}$

Q85. An alpha- particle of mass m suffers 1- dimensional elastic collision with a nucleus at rest of unknown mass. It is scattered directly backwards losing 64% of its initial kinetic energy. The mass of the nucleus is

12 Jan 2019 (E)

(1) $1.5m$ (2) $4m$
(3) $3.5m$ (4) $5m$

Q86. A simple pendulum, made of a string of length l and a bob of mass m, is released from a small angle θ_0. It strikes a block of mass M, kept on horizontal surface at its lowest point of oscillations, elastically. It bounces back and goes up to an angle θ_1. Then M is given by: *12 Jan 2019 (M)*

(1) $m\left(\frac{\theta_0-\theta_1}{\theta_0+\theta_1}\right)$ (2) $m\left(\frac{\theta_0+\theta_1}{\theta_0-\theta_1}\right)$
(3) $\frac{m}{2}\left(\frac{\theta_0+\theta_1}{\theta_0-\theta_1}\right)$ (4) $\frac{m}{2}\left(\frac{\theta_0-\theta_1}{\theta_0+\theta_1}\right)$

Q87. A body of mass 1 kg falls freely from a height of 100 m, on a platform of mass 3 kg which is mounted on a spring having spring constant $\mathrm{k} = 1.25 \times 10^6\ \mathrm{N/m}$. The bodysticks to the platform and the spring's maximum compression is found to be x. Given that $g = 10\ \mathrm{ms}^{-2}$, the value of x will be close to : *11 Jan 2019 (M)*

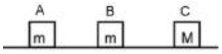
(1) 40 cm (2) 4 cm
(3) 80 cm (4) 8 cm

Q88. A piece of wood of mass 0.03 kg is dropped from the top of a 100 m height building. At the same time, a bullet of mass 0.02 kg is fired vertically upward, with a velocity 100 ms^{-1}, from the ground. The bullet gets embedded in the wood. Then the maximum height to which the combined system reaches above the top of the building before falling below is: $(g = 10\ ms^{-2})$ *10 Jan 2019 (M)*

(1) $40\ m$ (2) $20\ m$

(3) $10\ m$ (4) $30\ m$

Q89. Three blocks $\mathrm{A},\ \mathrm{B}$ and C are lying on a smooth horizontal surface, as shown in the figure. A and B have equal masses, m while C has mass M. Block A is given an initial speed v towards B due to which it collides with B perfectly inelastically. The combined mass collides with C, also perfectly inelastically. $\frac{5}{6}\mathrm{th}$ of the initial kinetic energy is lost in the whole process. What is the value of M/m?



09 Jan 2019 (M)

(1) 3 (2) 4

(3) 5 (4) 2

ANSWER KEYS

1. (2)	**2.** (4)	**3.** (15)	**4.** (2)	**5.** (4)	**6.** (3)	**7.** (3)	**8.** (2)
9. (4)	**10.** (4)	**11.** (4)	**12.** (2)	**13.** (1)	**14.** (1)	**15.** (2)	**16.** (1)
17. (125)	**18.** (2)	**19.** (2)	**20.** (5)	**21.** (4)	**22.** (4)	**23.** (3)	**24.** (4)
25. (2)	**26.** (1)	**27.** (3)	**28.** (2)	**29.** (8)	**30.** (2)	**31.** (2)	**32.** (2)
33. (2)	**34.** (3)	**35.** (6)	**36.** (3)	**37.** (3)	**38.** (10)	**39.** (12)	**40.** (1)
41. (400)	**42.** (4)	**43.** (25)	**44.** (2)	**45.** (1)	**46.** (4)	**47.** (20)	**48.** (1)
49. (4)	**50.** (4)	**51.** (3)	**52.** (4)	**53.** (3)	**54.** (2)	**55.** (1)	**56.** (3)
57. (120)	**58.** (4)	**59.** (51)	**60.** (20)	**61.** (2)	**62.** (1)	**63.** (3)	**64.** (10)
65. (23)	**66.** (2)	**67.** (2)	**68.** (1)	**69.** (3)	**70.** (2)	**71.** (1)	**72.** (1)
73. (4)	**74.** (4)	**75.** (1)	**76.** (1)	**77.** (3)	**78.** (3)	**79.** (2)	**80.** (4)
81. (1)	**82.** (2)	**83.** (1)	**84.** (1)	**85.** (2)	**86.** (1)	**87.** (2)	**88.** (1)
89. (2)							