PHYSICS

BOOKS - CENGAGE PHYSICS (HINGLISH)

CENTRE OF MASS CONVERSATION OF MOMENTUM AND COLLISION

Question Bank

1. Four cubes of side $a = 1m$ and of mass $40g$, $20g$, $10g$ and $20g$ are arranged in $x - y$ plane as shown in the figure. The co-ordinates of the centre of mass of the combination with respect to O are $x_c m$ and $y_c m$. Find $|x_{cm} + y_{cm}|$.

'(##CEN_KSR_PHY_JEE_C08_E01_001_Q01##)'

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2. Five uniform circular plates, cach of diameter D and mass m, are laid out in a pattern shown. Using the origin shown, the y co-ordinate of the centre of mass of the fiveplate system is $\frac{\alpha D}{\beta}$. Find $(\alpha + \beta)$.

'(##CEN_KSR_PHY_JEE_C08_E01_002_Q02##)'

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3. In the given figure, four rods AB, BC, CD and DA have masses m, $2m$, $3m$ and $4m$,

respectively..In which of the regions (numbered $1, 2, 3, 4$) the centre of mass of system lies?

'(##CEN_KSR_PHY_JEE_C08_E01_003_Q03##)'

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4. Two blocks A and B of masses $8kg$ and $4kg$ placed on a smooth horizontal ground are connected by a massless spring. An impulse provides a velocity of $3\frac{m}{s}$ to the block A. Find

the velocity (in $\frac{m}{s}$) of the centre of mass.

'(##CEN_KSR_PHY_JEE_C08_E01_004_Q04##)'

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5. A particle of mass $4m$, which is at rest, explodes into masses m, m and $2m$, two of the fragments of masses m and $2m$ are found to move with equal speed v each in opposite directions. The total mechanical energy released in the process of explosion is kmv^2. Find k.

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6. An open water tight railway wagon of mass $5 \times 10^3 kg$ moves at an initial velocity $1.2 m/s$ without friction on a railway track. Rain drops fall vertically downwards into the wagon. The velocity of the wagon after it has collected $10^3 kg$ of water will be :-

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7. A body of mass $1kg$ moving with velocity $1\frac{m}{s}$ makes an elastic one dimensional collision with an identical stationary body. They are in contact for brief time $1(\sim s)$. Their force of interaction increases from zero to F_0 linearly in time $0.5s$ and decreases linearly to zero in further time $0.5s$ as shown in the figure. The magnitude of force F_0 (in newton) is

'(##CEN_KSR_PHY_JEE_C08_E01_009_Q05##)'

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8. Two men of masses $80kg$ and $60kg$ are standing on a wooden plank of mass $100kg$, that has been placed over a smooth surface. If both the men start moving toward each other with speeds $1\frac{m}{s}$ and $2\frac{m}{s}$, respectively, then the magnitude of velocity of the plank by which it starts moving is $\left|\frac{p}{q}\right|\frac{m}{s}$. Find $(p+q)$.

'(##CEN_KSR_PHY_JEE_C08_E01_010_Q06##)'

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9. The given figure shows a disc of radius $R = 20cm$ with a portion of it removed symmetrically. The removed part is a disc, of radius $\frac{R}{2}$. The removed part is now placed in contact with the larger disc as shown in the figure. The disc has uniform mass distribution. With respect to origin O at centre of larger disc, find x -coordinate (in cm) of the centre of mass of system.

'(##CEN_KSR_PHY_JEE_C08_E01_011_Q07##)'

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10. A projectile of mass 3m explodes at highest point of its path. It breaks into three equalparts. One part retraces its path, the second one comes to rest. The range of the projectile was 100 m if no explosion would have taken place. The distance of the third part from the point of projection when it finally lands on the ground is -

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11. A particle of mass $m = 0.1kg$ is released from.rest from a point A of a wedge of mass $M = 2.4kg$. The wedge is free to slide on a frictionless horizontal plane. The particle slides down the smooth face AB of the wedge. When the velocity of the wedge is $0.2\frac{m}{s}$, the velocity (in $\frac{m}{s}$) of the particle relative to the wedge is

'(##CEN_KSR_PHY_JEE_C08_E01_013_Q08##)'

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12. Two balls of same mass are dropped from the same height h, on to the floor. The first ball bounces to a height $\frac{h}{9}$, and the second ball to a height $\frac{h}{36}$ after the collision. The impulse applied by the first and the second ball on the floor are I_1 and I_2, respectively. Find $\frac{7I_1}{I_2}$.

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13. A block of mass $1kg$ 'is pushed towards a movable wedge of mass $2kg$ and height

$h = 30cm$, with a velocity $u = 6\frac{m}{s}$. Before striking the wedge it travels $2m$ on a rough horizontal portion. The velocity is just sufficient for the block to reach the top of the wedge. Assuming all the surfaces are smooth except the given horizontal part and collision of block and wedge is jerkless, the friction coefficient of the rough horizontal part is (Round off the answer to two decimal places)

'(##CEN_KSR_PHY_JEE_C08_E01_015_Q09##)'

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14. During the head on collision of two bodies of masses $1kg$ and $2kg$, the maximum energy of deformation is $\frac{100}{3J}$. If before collision, the masses are moving.in the same direction, then their velocity of approach (in $\frac{m}{s}$) before the collision is

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15. A uniform solid right circular cone of base radius R is joined to a uniform solid hemisphere of radius R and of the same

density, as shown in the figure. The centre of mass of the.composite solid lies at the centre of base of the cone. The height of the cone is $\sqrt{x}R$. Find x.

'(##CEN_KSR_PHY_JEE_C08_E01_017_Q10##)'

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16. The given figure shows a square lamina with a disc of radius $\frac{L}{2}$ removed from it which is now placed symmetrically over upper right quarter. The location of the centre of mass of

the system relative to origin shown in the figure is $\frac{\pi L}{y}\left(\hat{i}+\hat{j}\right)$. Find y.

'(##CEN_KSR_PHY_JEE_C08_E01_018_Q11##)'

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17. A uniformly thick plate in the shape of an arrow head has dimensions as shown in the figure. Find the distance (in cm) of the centre of mass from point O.

'(##CEN_KSR_PHY_JEE_C08_E01_019_Q12##)'

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18. A $1kg$ ball is thrown horizontally as shown in the figure. If collision with the ground is perfectly inelastic, the kinetic energy of the ball immediately after the collision becomes $10x$ joule. Find the value of x.

'(##CEN_KSR_PHY_JEE_C08_E01_020_Q13##)'

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19. There are two vertical walls separated by a distance $3m$. A projectile is projected from the

foot of one wall with a speed $10\sqrt{2}\frac{m}{s}$ at angle 45° with horizontal as shown in the figure. During its motion, it collides many a times with vertical walls elastically. During collision, the velocity of the 'projectile perpendicular to wall get reversed and the one which is parallel to wall remains unchanged. The number of collision projectile will make with the vertical walls before hitting the ground is

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20. Two small boats, both having a mass of $150kg$ including passengers in it, are at rest. A sack of mass $50kg$ inakes 1^{st} boat having total mass of $200kg$. It is thrown to the second boat with a velocity whose, horizontal component is $2\frac{m}{s}$ relative to water. Calculate the distance (in m) between the boats $4.5s$ after. the throw, if the sack spent $0.5s$ in air. Neglect resistance of air and water.

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21. A small ball A is.thrown up with a velocity $40\frac{m}{s}$ from the ground. Another identical ball B of same mass is just dropped from a height of $50m$ simultaneously at time $t = 0$ so that both collide in air and stick together. Find the value of t (in s) at which combined mass will fall to the ground. $\left(g = 10\frac{m}{(s)^2}\right)$

'(##CEN_KSR_PHY_JEE_C08_E01_023_Q15##)'

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22. A cylindrical pot is slowly filled with. water. The centre of mass of the empty pot is at a height of $10cm$, the mass of the pot is $1kg$, and its inner area is $0.4m^2$. What is the height (in cm) of the water in it, if the centre of mass of the system is at the lowest position? (Take density of water $1000k\frac{g}{m^3}$.

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23. As shown in the figure, a small ball is moving with speed $2v$ towards wall A and both the walls are moving with constant velocity v towards each other. Find the speed v(in m / s), if the time taken by the ball in first three collision is $5s$. (Assume all collision are perfectly elastic and friction is absent)

'(##CEN_KSR_PHY_JEE_C08_E01_025_Q16##)'

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24. A ball is dropped freely from a height of $20m$ on to a hard fiat surface. The coefficient of restitution between the ball and the surface is 0.5. Find the time (in second) it takes to strike the surface for the second time.

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25. Two persons A and B of weight $80kg$ and $50kg$, respectively, are standing at opposite ends of a boat of mass $70kg$ and length $2m$ at

rest. When they interchange their positions, then displacement of the centre of mass of the boat will be xcm towards left. Find x.

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26. A ball of mass $2m$ impinges directly on a ball of mass m, which is at rest. If the velocity with which the larger ball impinges be equal to the velocity of the smaller mass after impact then the coefficient of restitution :-

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27. A bomb of mass $6kg$ is kept at the cẻntre of a closed box-also of mass $6kg$ and length $24m$. It explodes in two parts of mass $2kg$ and $4kg$. The two parts move in opposite direction and stick to the opposite sides of the walls of the box. The box is kept on a smooth horizontal surface. What is the distance (in m) moved by the box during this time interval.

'(##CEN_KSR_PHY_JEE_C08_E01_029_Q18##)'

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28. A ball falling vertically with speed $10\frac{m}{s}$ strikes the fixed inclined plane and rebound at 45° as shown in the figure. Find the value of $60e$, where e is coefficient of restitution.

'(##CEN_KSR_PHY_JEE_C08_E01_030_Q19##)'

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29. For the shown situation, if collision between block A and B is perfectly elastic, then find the maximum energy (in joules)

stored in the spring.

'(##CEN_KSR_PHY_JEE_C08_E01_031_Q20##)'

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30. In a physics lab, a small cube slides down a frictionless incline as shown in the figure, it strikes elastically and horizontally with a cube that is only one-half of its mass. If the incline is $20cm$ high and the table is $90cm$ off the floor, then big and small cubes strike the ground at a distance x and y metres, respectively, from

the table. Find the value of $\left(\frac{y}{x}\right)$.

'(##CEN_KSR_PHY_JEE_C08_E01_032_Q21##)'

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31. A $50kg$ man is standing at one end of a $3m$ long plank of mass $100kg$. The plank is sliding towards the right with uniform velocity of 2 m / s on the frictionless horizontal ground. The man walks to the other end of the plank in 5s. Find the distance travelled (in m) by the

man'relative to the ground in this 5 s interval.

'(##CEN_KSR_PHY_JEE_C08_E01_033_Q22##)'

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32. A cannon of miass $5m$ (including a shell of mass m) is at rest on a smooth horizontal ground. It fires the shell, with its barrel at an angle θ with the horizontal at a velocity u relative to itself. The horizontal' diśtance of the point where the shell strikes the ground

from the initial position of the cannon is $\frac{mu^2 \sin 2\theta}{ng}$. Find $(m+n)$,

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33. A bomb moving in a certain direction suddenly explodes into three identical pieces which fly off with equal speed. Two of the three pieces go in the same direction while the third one goes perpendicular to the other two. If K_f and K_i are the final and initial kinetic energiés of the system, then find $\frac{5K_f}{K_l}$.

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34. A man of $60kg$ is standing on a cart of mass double the mass of the man. Initially the cart is at rest on smooth ground. Now, the man jumps with relative velocity 2 m /s horizontally towards right with respect to the cart. The work done (in J) by man dúring the process of jumping is

'(##CEN_KSR_PHY_JEE_C08_E01_036_Q23##)'

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35. A proton makes a head-on collision with an unknown particle at rest. The proton rebounds straight back with $\frac{4}{9}$ of its initial kinetic energy. The ratio of the mass.of the unknown particle to that of proton, assuming that the collision is elastic, is

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36. A ball of mass m is moving with a speed v as shown in the figure. It undergoes inelastic

collision with a bail of mass $2m$ which was initially at rest. The velocity of ball $2m$ after collision is $\frac{\sqrt{p}v}{a}$. Find $(p+q)$.

'(##CEN_KSR_PHY_JEE_C08_E01_038_Q24##)'

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37. A bomb projected from ground at an angle $\theta(\theta \neq 90^\circ)$ explodes into two fragments of equal mass at topmost point of its trajectory. If one of the fragments returns to the point of projection, then the ratio of de-Broglie

wavelength of the second fragment just after explosion to that of bomb just before explosion is $\frac{x}{y}$. Find $(x+y)$.

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38. A marble bounces down a long flight of stairs in a regulàr manner, hitting each step vertically at the same speed and distance from the edge, and bouncing up to the same height above each step, as shown in the figure. Each stair has the same height and width l as

shown. The horizontal component of velocity V_k is unaffected, but the stairs have the property that $e = 0.6$ is a constant. Find the value V_i (in $\frac{m}{s}$). Ignore the size of the marble and air resistance. Assume the trajectory of the marble lies in the plane of the paper. (Given: l=0.8 m)

'(##CEN_KSR_PHY_JEE_C08_E01_040_Q25##)'

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