



PHYSICS

BOOKS - MODERN PUBLICATION

Centre of mass

Example

1. The distance between the centres of the carbon and oxygen atoms in the carbon monoxide (CO) gas molecule is

$1.12 \times 10^{-10} m$. Locate the centre of mass of the molecule relative to carbon atom.



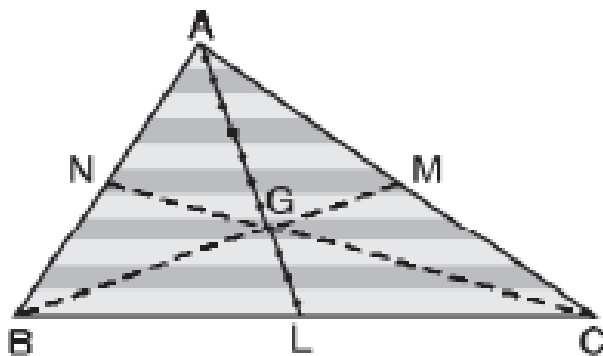
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2. Three particles of masses 100 g, 150 g and 200 g are placed at the vertices of an equilateral $\triangle ABC$ of each side 50 cm. Find the centre of mass of the system of three particles.



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3. Find the centre of mass of a triangular lamina.



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4. Consider a two - particle system with the particles having masses M_1 and M_2 .If the first particle is pushed towards the centre of mass

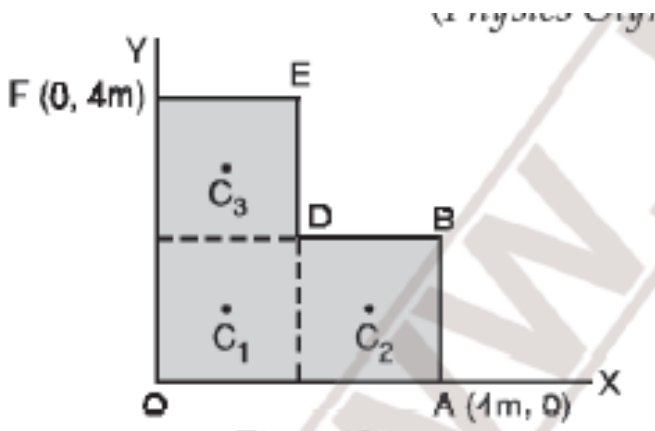
through a distance a , by what distance should the second particle be moved, so as to keep the centre of mass at the same position?



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5. A thin uniform flat plate of mass 4.5 kg is in the form of an L-shaped lamina. Its dimensions are as shown in Fig. Find the position of its

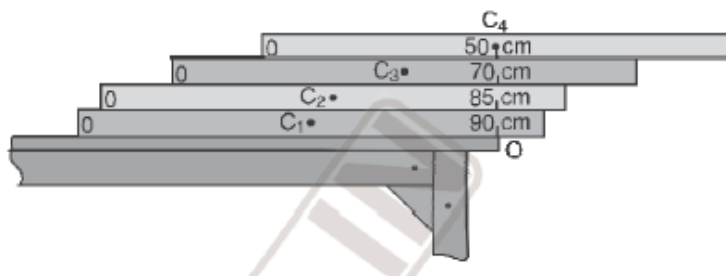
centre of mass.



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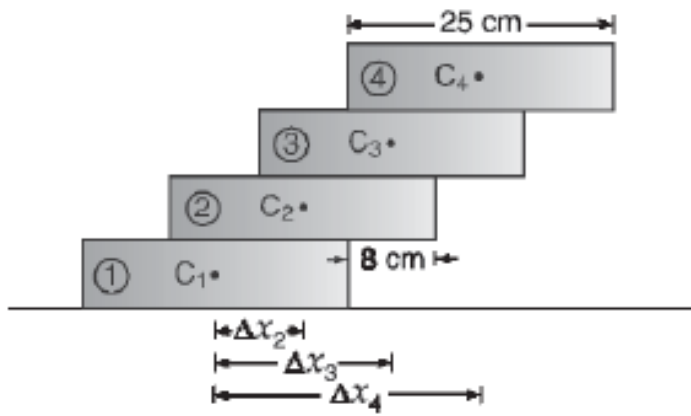
6. If four uniform and identical metre sticks were stacked on a table with 10 cm, 15 cm, 30 cm and 50 cm centre of segments over the edge as shown in Fig., would the metre sticks

remain on the table or topple down?



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7. Uniform and identical blocks 25 cm long are stacked, so that 8 cm of a block extends beyond the block beneath as shown in Fig.



. How

many blocks can be stacked in this way before the stack falls over?

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8. Two bodies of masses 10 g and 10 g having position vectors $3\hat{i} + 2\hat{j} - \hat{k}$ and $\hat{i} - \hat{j} + 3\hat{k}$

respectively. Find the position vector of centre of mass from the origin.



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9. Centre of mass is at $P(1,1,1)$ where the system consists of particles of mass 2,3,4 and 5kg. The centre of mass shifts to point $Q(2,2,2)$ on removing the mass of 5kg. What was its position?



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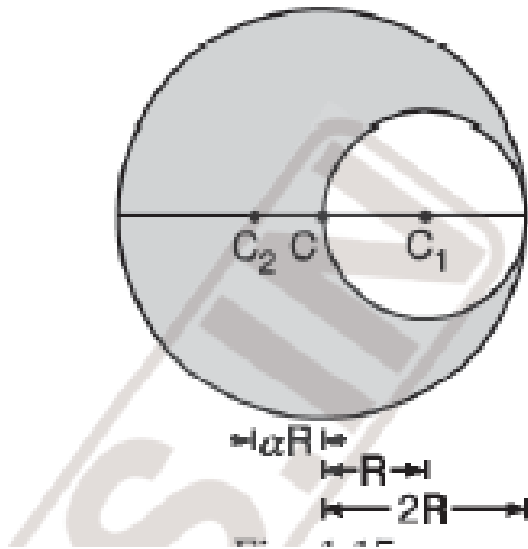
10. A rod is of length L and its mass acting per unit length is directly proportional to distance x from one of its end. Find the distance of its centre of mass from that end of the rod.



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11. A circular disc of radius R is removed from a bigger circular disc of radius $2R$ from one edge of the disc as shown in Fig. The centre of mass of the new disc is αR from the centre of

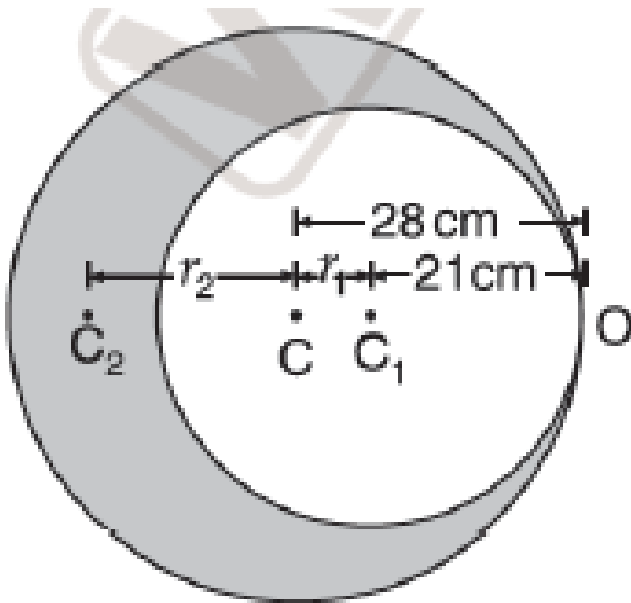
the bigger disc. Find the value of α .



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12. The circular plate of uniform thickness has a diameter of 56 cm. A circular portion of diameter 42 cm is removed from one edge of

the plate as shown in Fig. Find the position of the centre of mass of the remaining portion.



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13. Define centre of mass.

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14. Define centre of mass of a system of particles.



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15. Write down expression for the position vector of the centre of mass of a system consisting of two objects in terms of their masses and position vectors.



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16. Where does the centre of mass of a two particle system lie, if one particle is more massive than the other?



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17. Is centre of mass a reality?



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18. Should there exist mass at the location of centre of mass of a system?



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19. What will be the nature of motion of centre of mass of an isolated system?



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20. Where does the centre of mass of a rectangle lie?



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21. What is the location of centre of mass of a triangular lamina?



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22. Should the centre of mass of a body necessarily lie inside the body?



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23. Can centre of mass of a body be outside it ?

If so, give example.



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24. Give an example each for a body, where centre of mass lies inside the body and outside the body



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25. Define centre of mass.



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26. What will be the position of the centre of mass of two particles of equal masses, moving opposite to each other with the same velocity?



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27. Define centre of mass. Is it necessary that centre of mass should always lie inside the body?



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28. What do you mean by centre of mass of a body? Find the position of centre of mass of a uniform rod.



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29. What is the position of centre of mass in case of cylindrical body?



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30. What is the position of centre of mass in case of conical body?



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31. What is the position of centre of mass in case of circular ring?



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32. Prove that the centre of mass of two particles divides the line joining the particles in the inverse ratio of their masses



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33. How is it possible to describe the motion of a big system, when Newton's laws of motion are applicable to individual particles of the system? Explain.



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34. What is the significance of defining the centre of mass of a system?



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35. What is the importance of the study of centre of mass of a system in mechanics ?



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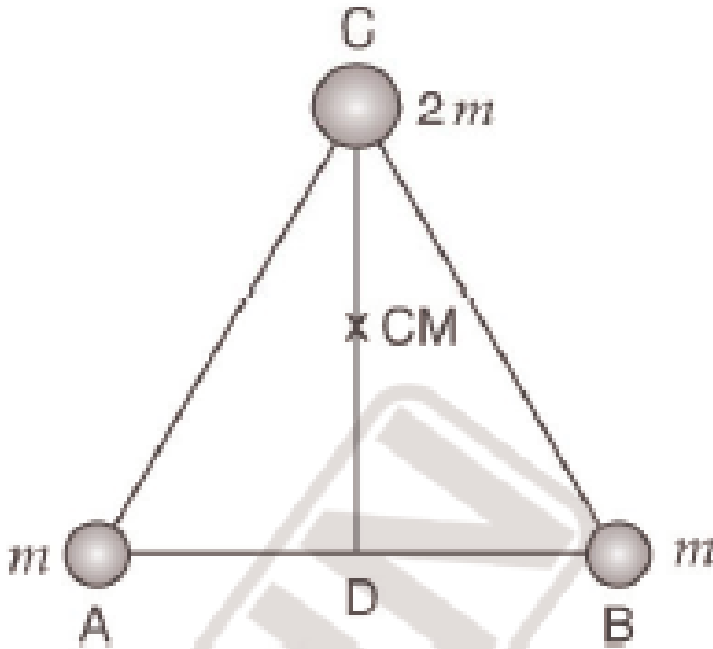
36. What is the difference between centre of gravity and centre of mass?



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37. Two balls each of mass m are placed on two vertices of an equilateral triangle. A ball of mass $2m$ is situated at the third vertex.

Determine the centre of mass of the system.



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38. A body A of mass M , while falling vertically downwards under gravity, breaks into two

parts: a body B of mass $\frac{M}{3}$ and a body C of mass $2\frac{M}{3}$. How does the centre of mass of bodies B and C taken together shift compared to that of body A?



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39. A rocket is out in free space shooting out a stream of exhaust gases and picking up speed in the opposite direction. What happens to the centre of mass of all the matter, that

which is ejected and that which is left in the rocket?



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Exercise

1. What is centre of mass of a system?



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2. Obtain an expression for the centre of mass of a system of two particles.



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3. What is centre of mass of a system?



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4. Write down expression for the position vector of the centre of mass of a system

consisting of two objects in terms of their masses and position vectors.



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5. Derive the equation of motion for a system of n particles under the effect of an external force.



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6. Why the internal forces among the various particles of a system do not affect the motion.



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7. What is centre of mass of a system?



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8. Write down expression for the position vector of the centre of mass of a system

consisting of two objects in terms of their masses and position vectors.



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9. Show that the centre of mass of a system moves with constant velocity, when no external force acts on a system system.



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10. Determine the co-ordinates of centre of mass of a system of n particles.



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11. Discuss the motion of centre of mass in the following system Earth-moon system revolving around the sun.



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12. Discuss the motion of centre of mass in the following system The Indian club thrown by a player towards the other.



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13. Discuss the motion of centre of mass in the following system The decay of a radioactive nucleus into two parts.



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14. Define the centre of mass of a system. Is centre of mass a reality?



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15. Write down expression for the position vector of the centre of mass of a system consisting of two objects in terms of their masses and position vectors.



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16. What do you mean by centre of mass of a system? Prove that the centre of mass of a system moves as if all the mass of the system was concentrated at the center of mass and all the external forces acting on the system were applied directly at this point



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17. Show that the centre of mass of a system moves with constant velocity, when no external force acts on a system system.



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18. The identical sphere A,B and C each of radius R are placed touching each other on a horizontal table. Where is the centre of mass of the system located relative to the centre of the sphere A?



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19. Two particles of masses hundred and 300 grams have positions $2\hat{i} + 5\hat{j} + 13\hat{k}$ and

$6\hat{i} + 4\hat{j} - 2\hat{k}$ CM respectively at a given time.

find the position of the centre of mass.



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20. two mass of 0.8 kg and 1 pound to kg are moving in xy plane at the locations whose coordinates are (1,-2) and (-3,4) respectively.

find the coordinates of the centre of mass of the system.



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21. Three masses of 0.5 kg 1.5 kg and 2.5 kg are located in xy plane at points (2,-3), (3,5) and (-4,-6) respectively. find the coordinates of the centre of mass of the system.



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22. two masses m_1 and m_2 move in a horizontal plane and collide. Given that $m_1 = 85\text{g}$ $m_2 = 200\text{g}$ and initially $v_1 = 6.48\text{cm s}^{-1}$ and $v_2 = -6.78\text{cm s}^{-1}$. find the velocity of the centre of mass.



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23. two point masses of 2kg and 3kg are moving along the same line with speeds $3ms^{-1}$ and $5ms^{-1}$ respectively. Find the speed of the centre of mass of the system if both the masses are moving in the same direction



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24. two point masses of 2kg and 3kg are moving along the same line with speeds $3ms^{-1}$ and $5ms^{-1}$ respectively. Find the speed of the centre of mass of the system if both the masses are moving in the opposite direction



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25. If the centre of mass of three particles of masses 10,20 and 30 g is at point (1,-2,3), then

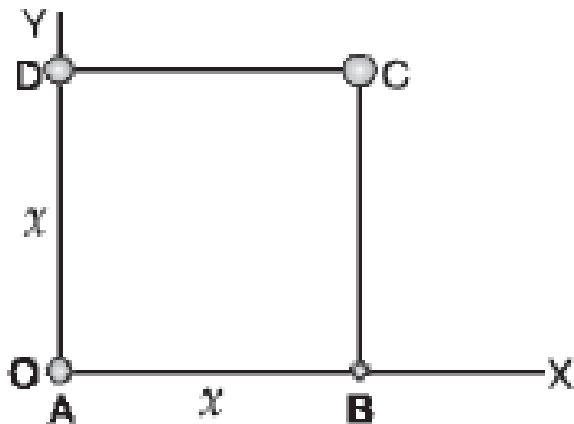
where should a fourth particle of mass 40 gram be placed so that the combined the centre of the mass of the system is at $(1,1,1)$?



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26. Four particles of masses $2m$, m , $4m$ and $3m$ are placed at the corners A,B,C and D of a square of each side x as shown in the figure. Find the position of centre of mass of the

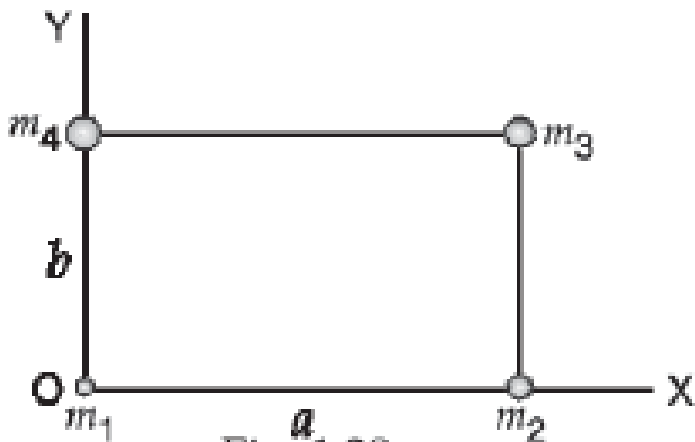
system.



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27. Four bodies of masses $m_1 = 1kg$, $m_2 = 2kg$, $m_3 = 3kg$ and $m_4 = 4kg$, located at the corners of a rectangle are shown in the

figure. find the position of centre of mass.



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28. Two blocks of masses 2kg and 5kg are placed on a frictionless table and connected by a spring. On giving a kick rahega block starts moving towards the other block with a

velocity of 9.8m s^{-1} . find the velocity of centre of mass.



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29. How many uniform identical text books with a width of 25cm can be stacked on the top of each obookr on a levelled surface without the stack falling over. If each successive book is displaced 3 cm in the width direction relative to the next lower book?



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30. From a uniform circular disc of radius R , a circular disc of radius $R/6$ and having centre at a distance $R/2$ from the centre of the disc is removed. Determine the centre of mass of remaining portion of the disc.



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