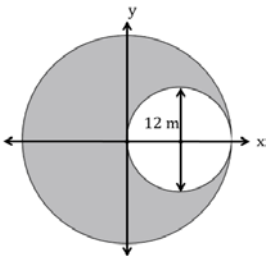
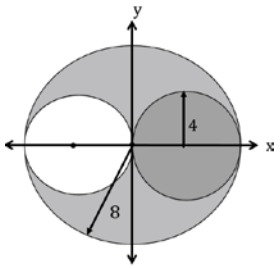
Position of COM

Q.1 A smaller disc is removed from a uniform circular lamina as shown in the figure. Find the position of COM of the uniform lamina, if diameter of the smaller disc is 12 m.



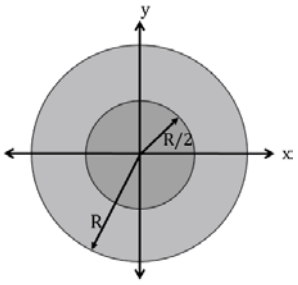
(A) $(-6,0)$m **(B)** $(-6,-6)$m **(C)** $(-2,0)$m **(D)** $(-2,-2)$m

Q.2 Figure given below shows a uniform disc of radius 8 units. A hole of radius 4 units has been cut out from left of its centre and is placed on the right of the centre of the disc. Find the COM of the resulting shape.



(A) $(4,0)$ **(B)** $(2,0)$ **(C)** $(6,0)$ **(D)** $(3,0)$

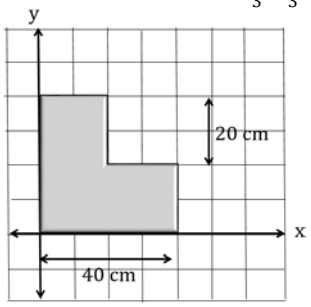
Q.3 Figure shows a uniform disc of radius R from which a hole of radius R/2 has been cut out from centre and filled with a material of twice the density of the original disc. Find the change in position of COM.



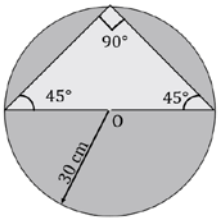
(A) COM will shift R/2 distance towards right. **(B)** COM will shift R/2 towards left.
(C) COM will shift 2R/3 distance towards right. **(D)** Position of COM will not change.

Q.4 A square section of side 20 cm is removed from the bigger square of side 40 cm as shown in the figure. Find the center of mass of the remaining portion of the square.

(A) $(\frac{50}{4},\frac{50}{4})$cm **(B)** $(25,25)$cm **(C)** $(\frac{50}{3},\frac{50}{3})$cm **(D)** $(20,20)$cm

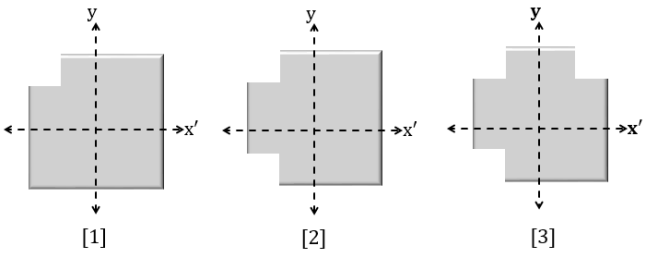


Q.5 From a circular disc of radius 30 cm, a triangular portion is cut as shown in the figure. The distance of the center of mass of the remaining portion from the center of the disc is (Assume mass density (mass/area) of the disc is σ)



(A) $\frac{10}{(\pi-1)}$ cm **(B)** $\frac{20}{(\pi-1)}$ cm **(C)** $\frac{30}{(\pi-1)}$ cm **(D)** $\frac{15}{(\pi-1)}$ cm

Q.6 A machinist starts with three identical square plates, but cuts one corner from on of them, two corners from the second and three corners from the third. Rank the three according to the x-coordinate of their centre of mass, from smallest to largest.



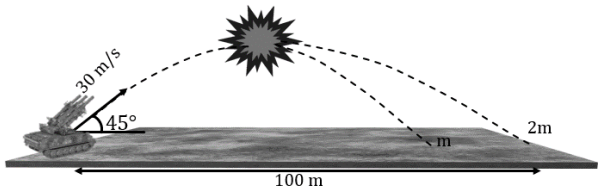
(A) 1,2,3 **(B)** 1,3,2 **(C)** 3,2,1 **(D)** Either a or b

Q.7 Two particles of masses 1 kg and 2 kg have displacement vectors $(7\hat{\imath} + 2\hat{\jmath} + 3\hat{k})$ m and $(2\hat{\imath} + 10\hat{\jmath} + 6\hat{k})$ m Find the displacement vector of the center of mass of the system.

(A) $\frac{1}{3}(22\hat{\imath} + 11\hat{\jmath} + 15\hat{k})$m **(B)** $\frac{1}{3}(11\hat{\imath} + 22\hat{\jmath} + 15\hat{k})$m

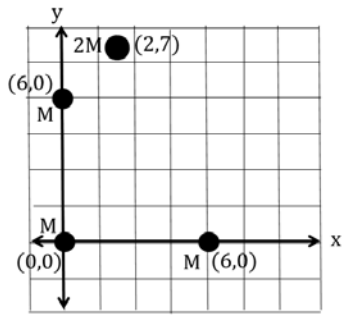
(C) $\frac{1}{3}(11\hat{\imath} + 15\hat{\jmath} + 22\hat{k})$m **(D)** $\frac{1}{3}(15\hat{\imath} + 22\hat{\jmath} + 11\hat{k})$m

Q.8 A projectile of mass 3m is projected from the ground with a velocity 30 m/s at 45° with the horizontal. At the highest point, it explodes into two pieces. One of pieces has mass 2m and the other has mass m. Both the piece fly off horizontally in opposite directions. Mass 2m falls at a distance of 100 m from the point of projection. Find the distance of second mass from the point of projection, where it strikes the ground. (Take $g = 10\ m/s^2$)



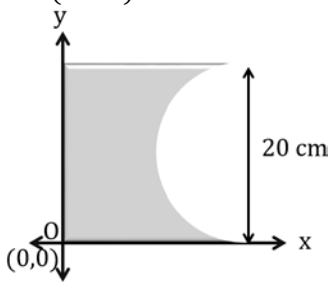
(A) 90 m **(B)** 60 m **(C)** 80 m **(D)** 70 m

Q.9 Three equal objects of mass M each are placed on a table at points (0, 0), (6, 0) and (0, 6) respectively. If another object of mass 2M is placed at point (2, 7), the displacement of COM is



(A) 2 units **(B)** $2\sqrt{2}$ units **(C)** $2\sqrt{3}$ units **(D)** 0 units

Q.10 A semicircular disc is cut out from a square sheet of side 20 cm as shown in the figure. Consider the material to be of uniform density and the origin to be at point O. What is the distance of the centre of mass of the new shape from y- axis? (in cm)



WORK SHEET

Integration

Q.1 Solve the integral $I = \int_0^{\pi} \sin^2 x dx$

(A) π **(B)** $\frac{\pi}{2}$ **(C)** 0 **(D)** $\frac{\pi}{4}$

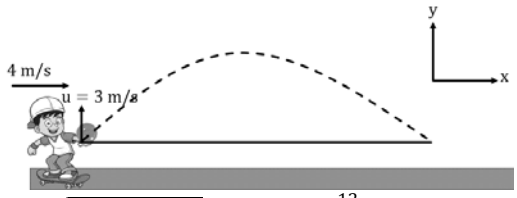
Average speed

Q.2 A train travels from a city A to city B with a constant speed of 10 m/s and returns back to city A in half of the time taken to travel from Ato B. Find its average speed during the entire journey.

(A) 40 m/s **(B)** 30 m/s **(C)** 15 m/s **(D)** $\frac{40}{3}$ m/s

Displacement

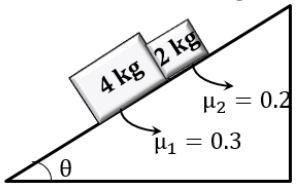
Q.3 A boy of height 1.5 m is moving on a skateboard due east with velocity 4 m/s. He throws a coin vertically upward with a velocity of 3 m/s relative to himself. Find the total displacement of the coin relative to ground till it comes to the hand of the boy. Take $g = 10\ m/s^2$.



(A) 0 **(B)** $\sqrt{0.45^2 + 12^2}$m **(C)** $\frac{12}{5}$m **(D)** $\sqrt{0.45^2 + 2.4^2}$m

Acceleration

Q.4 Figure shows two blocks in contact and sliding down the inclined surface of inclination 30°. Coefficient of friction between the block of mass 4 kg and the inclined plane is $\mu_1 = 0.3$ and that between the block of mass 2 kg and the inclined plane is $\mu_2 = 0.20$. Assume coefficients of static and kinetic friction to be equal. Find the acceleration of 2 kg block. Take $g = 10\ m/s^2$.

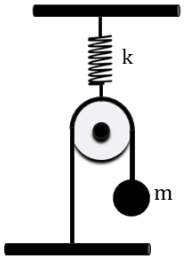


(A) $\frac{15-4\sqrt{3}}{3}$ m/s^2 **(B)** $5 - \sqrt{3}$ m/s^2 **(C)** $\sqrt{15}$ m/s^2 **(D)** 5 m/s^2

Elongation of spring

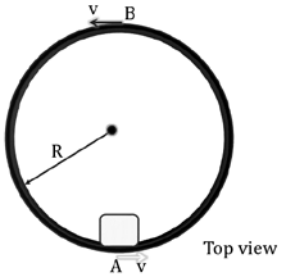
Q.5 A body of mass m hangs by as inextensible light string that passes over a smooth massless pulley that is fitted with a light spring of stiffness k as shown in the figure. If the body is released from rest, calculate the maximum elongation of the spring. Take $g = 10\ m/s^2$.

(A) $\frac{mg}{k}$ **(B)** $\frac{2mg}{k}$ **(C)** $\frac{4mg}{k}$ **(D)** $\frac{3mg}{k}$



Normal force

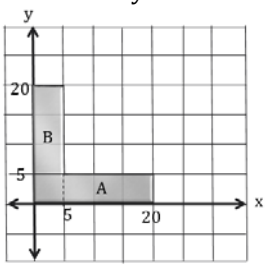
Q.6 A block of mass of m is projected along the surface of a smooth circular wall with velocity v. What is the value of average normal force exerted by the circular wall on the block during its motion from Ato B. Assume uniform speed during the journey.



(A) $\frac{mv^2}{R}$ **(B)** $\frac{mv^2}{\pi R}$ **(C)** $\frac{2mv^2}{R}$ **(D)** $\frac{2mv^2}{\pi R}$

Position of COM

Q.7 An L – shaped lamina is shown in the figure given below. Both rectangular sheets are made of the same material of negligible thickness. Find the y coordinate of COM of the system.

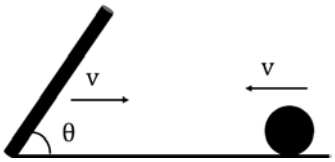


(A) 6.78 **(B)** 10 **(C)** 12.5 **(D)** 7.5

Impulse

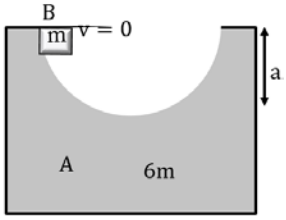
Q.8 A sphere of mass m slides with velocity v on a frictionless surface towards a smooth inclined wall as shown in figure. If the sphere returns with the same speed after collision with the wall, then the impulse imparted by the inclined wall on the sphere will be:

(A) 2mvcosecθ **(B)** 2mvsinθ **(C)** 2mvcotθ **(D)** 2mvtanθ



Speed

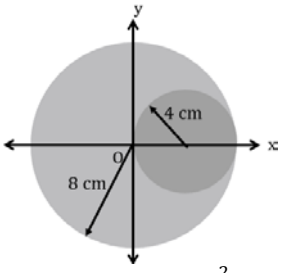
Q.9 Figure shows a block A of mass 6m having a smooth semicircular groove of radius a placed on a smooth horizontal surface. A block B of mass m is released from rest from horizontal position as shown in the figure. Find the speed of the bigger block 6m, when the smaller block reaches the bottommost position of the groove. Take $g = 10\ m/s^2$.



(A) $\sqrt{\frac{ga}{14}}$ (B) $\sqrt{\frac{ga}{21}}$ (C) $\sqrt{\frac{ga}{10}}$ (D) $\sqrt{\frac{ga}{36}}$

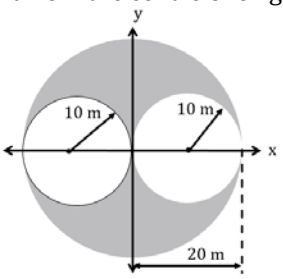
Position of COM

Q.10 A sphere of radius 4 cm is removed from a sphere of radius 8 cm as shown in figure. If O is the COM of the complete sphere, the position of COM of the remaining sphere will shift towards left from O by



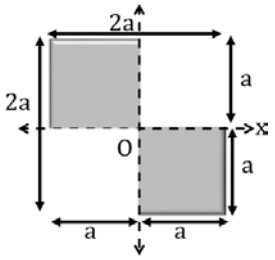
(A) $-\frac{4}{7}$ cm **(B)** $\frac{4}{7}$ cm **(C)** $\frac{2}{7}$ cm **(D)** $-\frac{2}{7}$ cm

Q.11 From a uniform circular disc of radius 20 cm, two small circular discs of radius 10 cm are removed in such a way that both have common tangent as shown in the figure given below. The distance of centre of mass of the remaining part from the centre of original disc is:



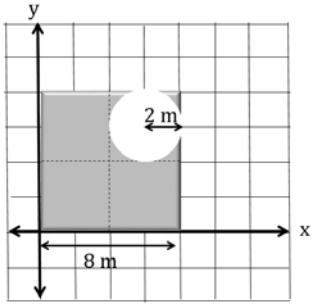
(A) 10 cm **(B)** 0cm **(C)** 5cm **(D)** 20 cm

Q.12 Two squares of size (a × a) each are removed from a bigger square of size (2a × 2a) as shown in the figure. Removed parts are unshaded in the figure given below. Find the coordinates of the COM w.r.t the origin O.



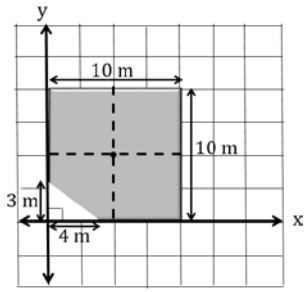
(A) $(\frac{a}{\sqrt{2}}, \frac{a}{\sqrt{2}})$ **(B)** $(\frac{a}{2}, \frac{a}{2})$ **(C)** (0,0) **(D)** (a, a)

Q.13 From a square plate of side 8 m, a circular disc of radius 2 m is removed as shown in the figure. The mass density of the square plate is 1 kg/m^2. Find the center of mass of the remaining portion.



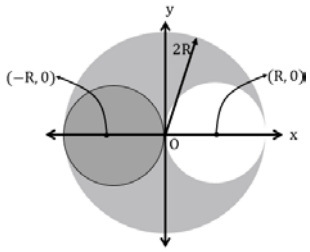
(A) (4.9,4.9)m **(B)** (3.51,3.51)m **(C)** (2,2)m **(D)** (2.5,2.5)m

Q.14 From a square plate of side 10 m, a right angled triangle is removed as shown in the figure. The square plate has mass density 2 kg/m^2. Find the centre of mass of the remaining portion. Assume the origin to be at the intersection of x and y axes.



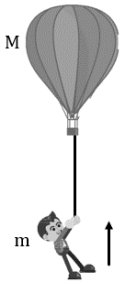
(A) (4.2,6.5)m **(B)** (55)m **(C)** (5.23,5.25)m **(D)** (6.25,6.32)m

Q.15 A uniform disc of mass m and radius R is cut from the right side of the larger disc of mass M and radius 2R and kept on the left side as shown in the figure (shaded portion). Find the COM of the system w.r.t the origin O.



(A) $(\frac{R}{3}, 0)$ **(B)** $(\frac{R}{2}, 0)$ **(C)** $(-\frac{R}{3}, 0)$ **(D)** $(-\frac{R}{2}, 0)$

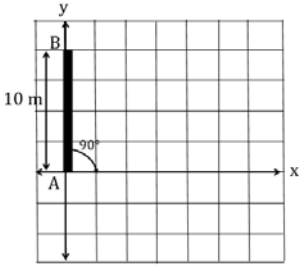
Q.16 A man of mass m is suspended in the air by holding the rope of a stationary balloon of mass M. As the man starts climbing up the rope, the balloon will



(A) Move upward. **(B)** Move downward. **(C)** Remain stationary. **(D)** Cannot say.

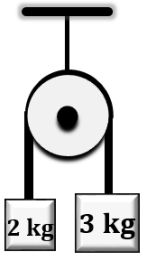
Displacement of COM

Q.17 A rod of length 10 m is placed in vertical direction. Then the rod is rotated by 90° in clockwise direction. Find out the displacement of the COM of the rod.



(A) $5\sqrt{2}$m **(B)** $\frac{5}{\sqrt{2}}$m **(C)** 5m **(D)** $2\sqrt{5}$m

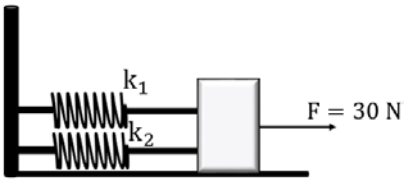
Q.18 Two blocks of masses 3 kg and 2 kg respectively are tied to the ends of a string which passes over a light pulley as shown in the figure below.The masses are held at rest at the same horizontal level and then released. The distance moved by COM is 5 seconds is



(A)10 m Upward. **(B)**5 m Downward. **(C)**10 m Downward. **(D)**5 m Upward.

Equilibrium

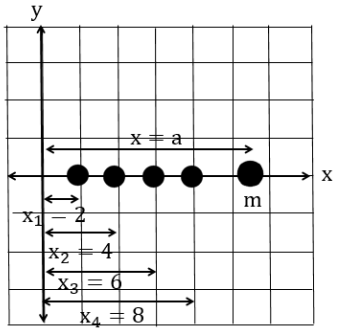
Q.19 For the spring block arrangement as shown in figure, Given that $k_1 = 2k_2$. If force applied by the first spring on the block is F_1 and force applied by the second spring on the block is F_2, choose the correct option(s) if the block is in equilibrium with the action of an external force 30 N on the block.



(A)$x_1 = 2x_2$ **(B)**$x_1 = x_2$ **(C)**$F_1 = F_2 = 30$ N **(D)**$F_1 = 20$ N, $F_2 = 10$ N

Position of COM

Q.20 4 particles of mass 2 kg each are placed on the x-axis at positions $x_1 = 2$, $x_2 = 4$, $x_3 = 6$and $x_4 = 8$. If another mass of m kg is placed on x-axis at $x = a$, choose the correct statements.



(A) If $m = 4$ mg, $a = 8$, COM will move by 2 units distance.

(B) If $m = 4$ kg, $a = 8$, COM will move by 1 unit distance.

(C) If $a = 5$, COM will not move by any distance.

(D) If $a = 5$, COM will move by a distance which depends on the value of m.

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(C)	(B)	(D)	(C)	(A)	(D)	(B)	(D)	(A)	6.28 cm
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(B)	(D)	(C)	(A)	(C)	(D)	(A)	(A)	(B)	(B)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(B)	(C)	(B)	(C)	(D)	(B)	(A)	(B)	(B,D)	(B,C)