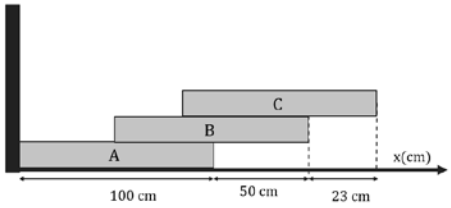
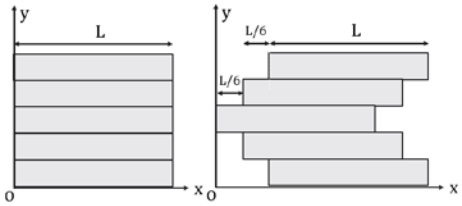
Center OF Mass

Q.1 Three uniform bricks each of length 100 cm and mass m are arranged as shown in figure. The distance of centre of mass of the system of bricks from the wall is.



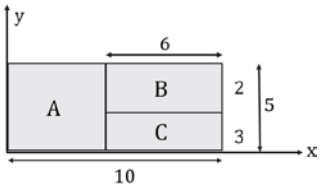
(A)91 cm **(B)** 100cm **(C)** 75 cm **(D)**125 cm

Q.2 Five homogeneous bricks, each of length $L = 9$ m are arranged as shown in the figure. Each of the bricks is displaced with respect to the next one in contact by $\frac{L}{6}$ as shown in the figure below. Find the $x-$ coordinate of the centre of mass relative to origin O.



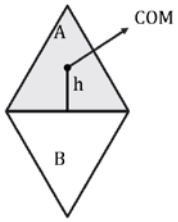
(A)2.1m **(B)** 5.4 m **(C)** 4.5 m **(D)**6.3 m

Q.3 Three rectangular platesA, B and C made up of three different materials are joined together to form a large rectangular plat as shown in figure. If the densities of A, B and C are in the ratio$2 : 5 : 3$,then.



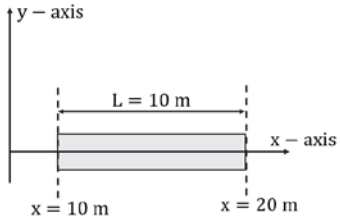
(A)COM lies inside A **(B)** COM lies inside B
(C) COM lies inside C **(D**) COM lies outside all three sheets

Q.4 Two equilateral triangular plates are joined together to form the following figure. Density of plate A is 3 times that of plate B. If COM lies inside the plate A at a distance $h = \sqrt{3}$ m from their common side, find out the length of side of each triangular plate.



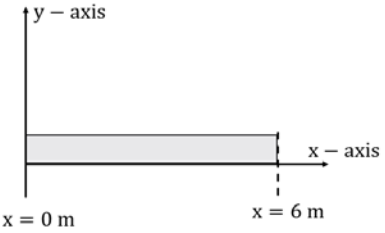
(A)$6\sqrt{3}$ m **(B)** 6 m **(C)** $\frac{6}{\sqrt{3}}$ m **(D**) $3\sqrt{3}$ m

Q.5 A uniform rod of length 10 m is placed along $x-$ axis as shown in figure. The distance of the centre of mass of the from the origin is.



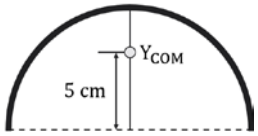
(A)20 m **(B)** 5m **(C)** 15 m **(D)**25 m

Q.6 A rod of length 6 m is placed along the x − axis between x = 0 and x = 6 m. The linear density (mass/length) λ of the rod varies with the distance x from the origin as λ = k(10 − x).Here k is a positive constant. Find the position of the centre of mass of this rod.



(A)(1.32 m, 0 m, 0 m) **(B)** (3 m, 0 m, 0 m) **(C)** (2.57 m, 0 m, 0 m) **(D)** (3.9 m, 0 m, 0 m)

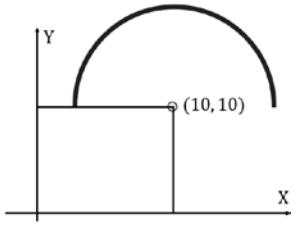
Q.7 The centre of mass of a semi-circular ring lies 5 cm above the centre of the semi-circle. What is the circumference of the ring?



(A)20.67 cm **(B)** 27.48 cm **(C)** 24.67 cm **(D)** 18.56 cm

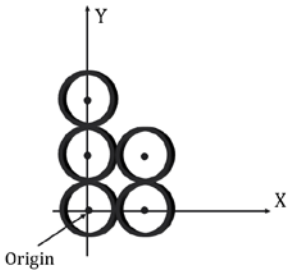
Q.8 A semicircular ring of radius 2π is situated in X – Y plane having centre at (10, 10) as shown in the figure below. Find the co-ordinates of centre of mass of the ring.

(A)(12, 10) **(B)** (10, 14) **(C)** (14, 14) **(D)**(10, 10)

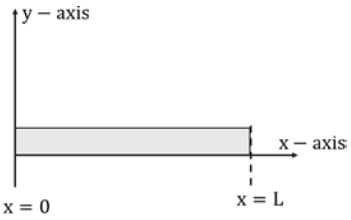


Q.9 Five uniform rings, each of diameter 5 *cm* and mass 10 *g* are arranged as shown in the figure. Using the origin shown, the $y-$ co-ordinate of COM of the five ring system is .

(A)4 m **(B)** 5 cm **(C)** 0.4 cm **(D)** 0.4 m



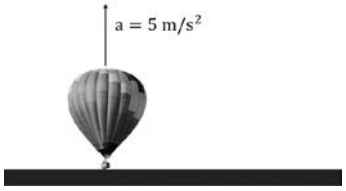
Q.10 A rod of length L is placed along the x − axis between x = 0 and x = L. The linear density (mass/length) λ of the rod varies with the distance x from the origin as $\lambda = kx^2$.Herek is a positive constant. Then, the x coordinate of the centre of mass of this rod will be $\frac{L}{n}$, where n is


y – axis
x – axis
x = 0
x = L

WORK SHEET

Time

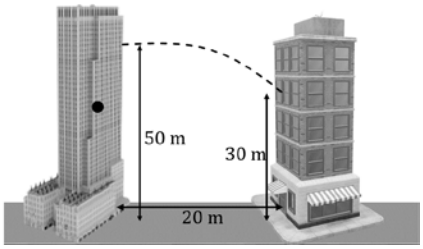
Q.1 A balloon is released from the ground (h = 0 m) from rest and starts accelerating with acceleration 5 m/s^2 vertically upwards. An object is dropped from the balloon, when it is at height 10 m from the ground. If the balloon is released att = 0 sec, then find the time when the object reaches the ground. Take (g = 10 m/s^2).



(A) 2.73s **(B)** 4.73 s **(C)** 4 s **(D)** 2 s

Projectile Motion

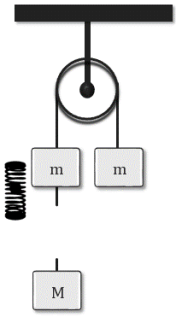
Q.2 Two building A and B are 20 m apart. Building A has a window at a height of 50 m above the ground and building B has a window at height 30 m from the ground. At what speed must a man throw a ball horizontally from the window of building A so that it enters the window of building B. (Take g = 10 m/s^2).



(A) 5 m/s **(B) 15** m/s **(C)** 10 m/s **(D)** 20 m/s

Spring Force

Q.3 The system shown in the figure is released from rest. The spring gets elongated if:



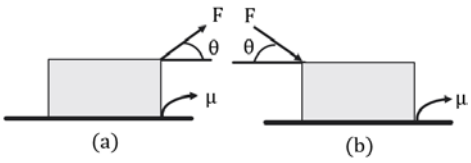
(A) M > m **(B)** M > 2m **(C)** M > $\frac{m}{2}$ **(D)** Any value of m

Force

Q.4 A block of mass m is lying on a horizontal surface and the coefficient of static friction between the block and surface is μ. Force F is applied at an angle θ with the horizontal in two different ways as shown in the figure.

(A) If μ = 0, F is lesser in case (a) **(B)** If μ = 0, F is lesser in case (b)

(C) If μ ≠ 0, F is lesser in case (a) **(D)** If μ ≠ 0, F is lesser in case (b)



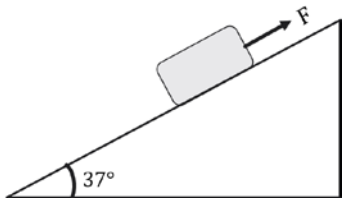
Vertical Circular Motion

Q.5 A stone tied to an inextensible string of length 1 m is released from horizontal position. The stone is free to revolve in a vertical plane around the other end of the string. Find the angular speed of the stone when the string makes an angle $\theta = 30°$ with horizontal. Take $g = 10\ m/s^2$.

(A) $\omega = 4$ rad/s **(B)** $\omega = \sqrt{15}$ rad/s **(C)** $\omega = \sqrt{10}$ rad/s **(D)** $\omega = 2.5$ rad/s

Work Done

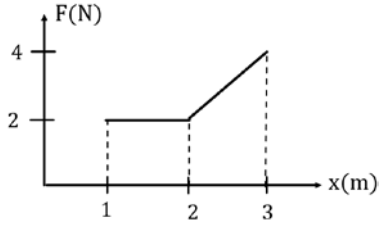
Q.6 A block of mass 10 kg is slowly slide up a smooth inclined plane of inclination 37° by a person. Calculate the work done by the person in moving the block through a distance of 20 m along the incline, if the person applies the force parallel to the inclined plane. Takeg $= 10\ m/s^2$.



(A) 400 J **(B)** 100 J **(C)** 1600 J **(D)** 1200 J

Kinetic Energy

Q.7 Starting from rest, a particle is moving along $x-$axis. The variation of force F with position x is shown in figure. Find the KE of the particle when it has moved from $x = 1$ m to $x = 3$ m.



(A) 3.3 J **(B)** 4J **(C)** 5J **(D)** 4.2 J

Potential Energy

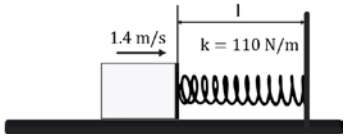
Q.8 The potential energy variation between two atoms as a function of the distance between them is given by $U(x) = U0\left[\left(\frac{a}{x}\right)^{12} - 2\left(\frac{a}{x}\right)^{6}\right]$, U_0, $a > 0$. Find the equilibrium position and state the nature of equilibrium (stable or unstable).

(A) $x_0 = 2a$ and stable (B) $x_0 = a$ and stable

(C) $x_0 = 2a$ and unstable (D) $x_0 = a$ and unstable

Spring Force

Q.9 A 3 kg block collides with a massless spring of spring constant 110 N/m attached to a wall. The speed of the block was observed to be 1.4 m/s at the moment of collision. The acceleration due to gravity is $9.8\ m/s^2$. How far does the spring compress if the horizontal surface on which the mass moves is frictionless?

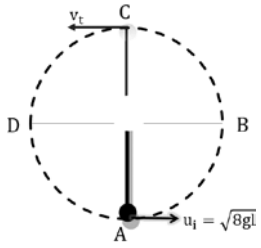


(A) 0.23 m **(B)** 0.41 m **(C)** 2.5 m **(D)** 3.2 m

Vertical Circular Motion

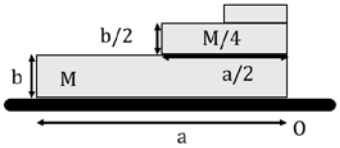
Q.10 A particle of mass m attached to a string of length l fixed at a point such that it can perform circular motion in a vertical plane. The particle is imparted a velocity of $\sqrt{8gl}$ at the lowest position by a sharp hit. Find the ratio of tension in string at the lowermost position to the tension in the string at the topmost position of the vertical circular path. Takeg $= 10\ m/s^2$.

(A) 3:1 **(B)** 9:5 **(C)** 7:3 **(D)** 7:5



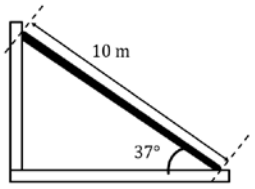
Centre of Mass

Q.11 An infinite number of bricks are placed one over the other as shown in the figure. Each succeeding brick having half the length and breadth of its preceding brick and the mass of each succeeding brick being $\frac{1^{th}}{4}$ of the preceding one. Take O as the origin. The $x-$ coordinate or centre of mass of the system of bricks is:



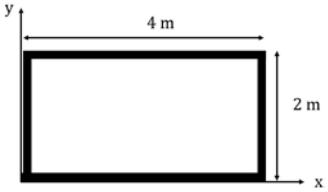
(A) $-\frac{a}{7}$ **(B)** $\frac{3a}{7}$ **(C)** $-\frac{3a}{7}$ **(D)** $-\frac{2a}{7}$

Q.12 A rod of length 10 m is inclined on the wall at an angle 37° with horizontal. Find out position of centre of mass of the rod assuming the wall to be along $y-$ axis and foot of the wall as the origin.



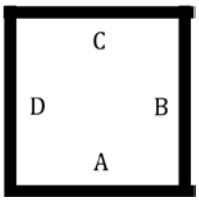
(A) (5m, 4m) **(B)** (4m, 5m) **(C)** (5m, 3m) **(D)** (4m, 3m)

Q.13 Four uniform rods of mass m kg each form a rectangle as shown in figure. The rods have negligible areas of cross-section. Find the position of center of mass of the rectangle made up of the four uniform rods.



(A) (2,2)m **(B)** (2,0)m **(C)** (2,1)m **(D)** (4,2)m

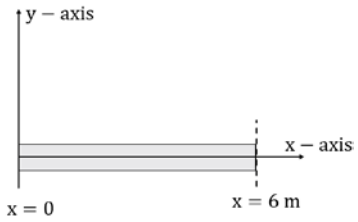
Q.14 Four uniform rods of different densities are connected to each other to form a square as shown in figure. Linear mass density of A, B, C and D are given as λ, 2λ, 2λ and 5λ. Find out the distance of COM of the square from the rod A if length of each rod is l.



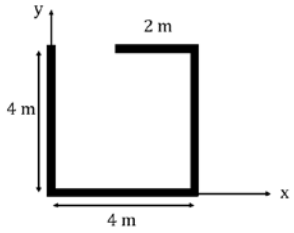
(A) l **(B)** $\frac{3}{4}$l **(C)** 0.55l **(D)** 0.45l

Q.15 A rod of length 6 m is placed along the x − axis between x = 0 and x = 6 m. The linear density (mass/length) λ of the rod varies with the distance x from the origin as $\lambda = k(100 - x^2)$.
Here k is a positive constant. Find the position of the centre of mass of this rod.

(A) (2.79m, 0m, 0m) **(B)** (2m, 0m, 0m) **(C)** (3m, 0m, 0m) **(D)** (6m, 0m, 0m)

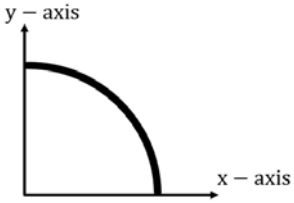


Q.16 A wire of mass m kg with uniform cross section is bent in the shape as shown in figure. If origin is taken at O, find the co-ordinates of the center of mass of the given system (in meters).



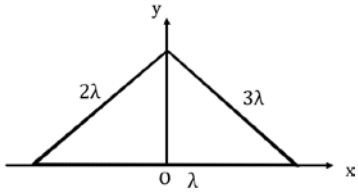
(A) $(\frac{15}{14}, \frac{12}{14})$ **(B)** $(\frac{15}{7}, \frac{12}{7})$ **(C)** (2,2) **(D)** $(\frac{12}{7}, \frac{15}{7})$

Q.17 In the figure shown below, a quarter ring of radius r is placed in the first quadrant of a Cartesian co-ordinate system, with centre at origin. Find the co − ordinates ofCOM of the quarter ring.



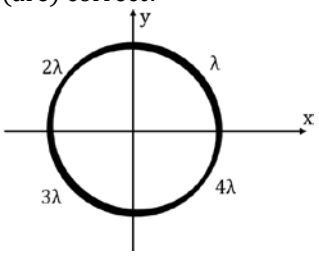
(A) $(\frac{2R}{\pi}, \frac{2R}{\pi})$ **(B)** $(\frac{2R}{\pi}, 0)$ **(C)** $(0, \frac{2R}{\pi})$ **(D)** (0,0)

Q.18 An equilateral triangular wire frame is made up of three thin uniform rods of mass per unit length λ, 2λ and 3λ as shown in figure. Assuming the origin to be at point O, which of the following options is(are) correct regarding the position of COM of system?



(A) $x_{cm} > 0$ **(B)** $y_{cm} < 0$ **(C)** $x_{cm} < 0$ **(D)** $y_{cm} > 0$

Q.19 A circular wire frame is made of four uniform quarter circular wires of same radius and of mass per unit length λ, 2λ, 3λ and 4λ as shown in figure. Assuming the origin to be at the centre of the circle, which of the following options is (are) correct?



(A) $x_{com} = 0$ **(B)** $y_{com} = 0$ **(C)** $y_{com} < 0$ **(D)** $x_{com} < 0$

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(A)	(D)	(C)	(B)	(C)	(C)	(C)	(B)	(C)	$(\frac{3L}{4})$
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(B)	(C)	(D)	(C)	(C)	(D)	(C)	(B)	(A)	(A)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(C)	(D)	(C)	(C)	(A)	(B)	(A)	(A)	(A)	