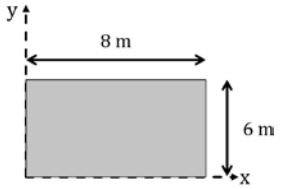
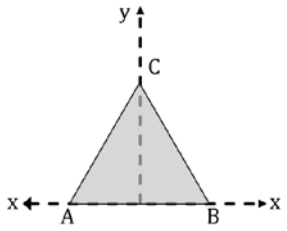
Centre of Mass

Q.1 Find the centre of mass of a rectangular lamina having sides 8 m and 6 m as shown in figure. [Take O as origin]



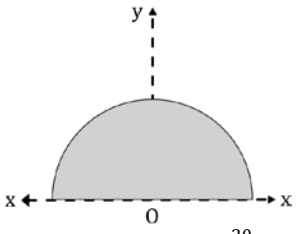
(A) (3,4)m **(B)** (4,3)m **(C)** (3,3)m **(D)** (4,4)m

Q.2 Find the height of the center of mass of the equilateral triangular lamina from the side AB as shown in figure. Given, side of the triangular lamina is 3 m.



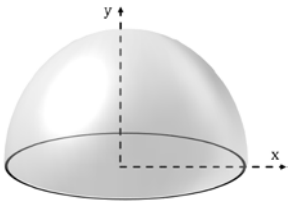
(A) $\sqrt{3}$m **(B)** $\frac{3}{\sqrt{2}}$m **(C)** $\frac{\sqrt{3}}{2}$m **(D)** $\frac{\sqrt{2}}{3}$m

Q.3 Find the height of the center of mass of a semi-circular disc of radius R = 20 cm from point O (base center).



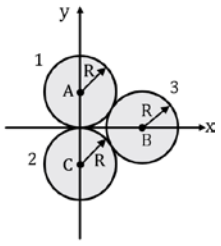
(A) $\frac{40}{3\pi}$cm **(B)** $\frac{60}{3\pi}$cm **(C)** $\frac{20}{3\pi}$cm **(D)** $\frac{80}{3\pi}$cm

Q.4 Find the position of the center of mass of a hollow hemisphere of radius R = 10 cm. Assume center O as origin.



(A) (0,10)cm **(B)** (0,2.5)cm **(C)** (0,5)cm **(D)** (0,0)cm

Q.5 Three discs of the same mass and same radius R are placed as shown in figure. Find the COM of the system.



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

Q.6 Three hollow spheres of same mass and radius are placed as shown in figure. Find the COM of the system.

(A) $(0, \frac{2}{3})$ **(B)** $(\frac{2}{3}, 0)$ **(C)** $(0, \frac{4}{3})$ **(D)** $(\frac{4}{3}, 0)$

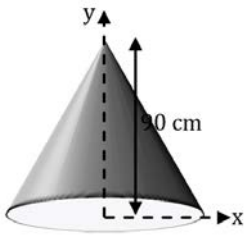
Q.7 Ten solid spheres of same radius having densities $\rho, 2\rho, 5\rho \ldots 10\rho$ respectively are put on the $x-$ axis at positions $x = 1, x = 2, x = 3 \ldots x = 10$. Find the position of centre of mass of these ten spheres.

(A) $x = 9$ **(B)** $x = 7$ **(C)** $x = 0$ **(D)** $x = 6$

Q.8 A solid cone has a height of 20 cm. Find the distance of center of mass of the cone from the center of the base of the cone.

(A) 15 cm **(B)** 5cm **(C)** 10cm **(D)** 12.5cm

Q.9 Find the co-ordinates of the center of mass of a hollow cone having a height of 90 *cm* as shown in the figure.



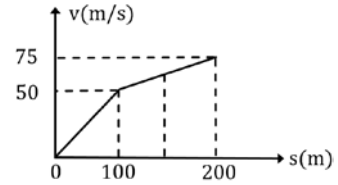
(A) (0,45)cm **(B)** (0,60)cm **(C)** (0,30)cm **(D)** (0,25)cm

Q.10 Find the height(in cm) of the center of mass of a solid hemisphere of radius $R = 8$ cm from its geometric center.

WORK SHEET

Velocity-displacement curve

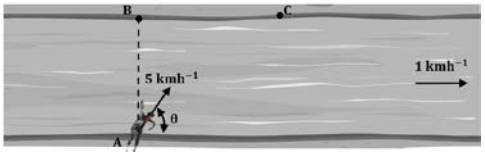
Q.1 The velocity-displacement graph for a car on a straight road is shown in figure. Determine the acceleration of the car at $s = 150$ m.



(A) $62.5\ m/s^2$ **(B)** $114\ m/s^2$ **(C)** $15.625\ m/s^2$ **(D)** $10.75\ m/s^2$

Relative Motion

Q.2 A river is flowing with a speed of $1\ kmh^{-1}$.A swimmer wants to go to point C starting form A. He swims with a speed of $5\ kmh^{-1}$ at an angle θ with the river flow. If $AB = BC = 400$ m, at what angle with the riverbank should the swimmer swim?



(A) $\theta = \frac{1}{2}\sin^{-1}\frac{24}{25}$ **(B)** $\theta = \frac{1}{2}\sin^{-1}\frac{12}{25}$ **(C)** $\theta = \frac{1}{2}\sin^{-1}\frac{16}{25}$ **(D)** $\theta = \frac{1}{2}\sin^{-1}\frac{9}{25}$

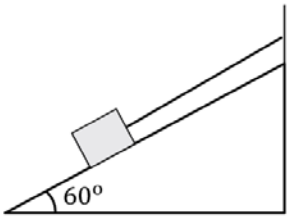
Pseudo Force

Q.3 A bob of mass m is suspended from a ceiling of a trolley by a light inextensible string. When the trolley accelerates horizontally, the string makes an angle θ with the vertical. Then choose the correct statement.

(A) θ Depends on the acceleration of trolley only
(B) θ Depends on the acceleration of trolley and acceleration due to gravity
(C) θ Depends on mass of bob, acceleration of trolley and acceleration due to gravity
(D) None of these

Friction on Inclined plane

Q.4 A block of mass 1 kg is placed on a rough inclined plane at an angle $\theta = 60°$ with the horizontal and the block is connected with a string as shown in figure. If coefficient of friction between the block and inclined surface $\mu_s = 3/4$, find the tension in string. [Take $g = 10\ m/s^2$]



(A) 0.66 N **(B)** 4.9 N **(C)** 5 N **(D)** 0 N

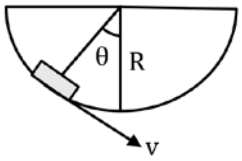
Radius of Curvature

Q.5 A particle is projected at an angle θ with horizontal, with velocity v_o at $t = 0$. Find the radius of curvature at $t = 0$.

(A) $\frac{v_o^2}{g\cos\theta}$ **(B)** $\frac{v_o^2\cos\theta}{g}$ **(C)** $\frac{(v_o\cos\theta)^2}{g}$ **(D)** $\frac{v_o^2}{g}$

Tangential Acceleration

Q.6 A coin is pushed down tangentially from an angular position θ on a circular surface, with velocity v as shown. If the coefficient of friction between the coin and surface is μ, find the tangential acceleration of the coin.



(A) $g\sin\theta$ **(B)** $g\sin\theta - \mu g\cos\theta$
(C) $g\sin\theta - \mu g\cos\theta - \mu v^2/R$ **(D)** $g\sin\theta - \mu v^2/R$

Conservative and Non-conservative Forces

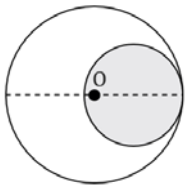
Q.7 For which of the following forces can the work done increase or decrease the potential energy?
(A) For both conservative and non-conservative forces
(B) For conservative forces only
(C) For non-conservative forces only
(D) For neither conservative nor non-conservative forces

Vertical Circular Motion

Q.8 A particles rests on the top of a smooth hemisphere of radius r.It is imparted a horizontal velocity of $\sqrt{gr}$. Find the normal reaction when it makes an angle $\theta = 60°$ with vertical.
(A) 1.5mg **(B)** 2.5mg **(C)** -1.5mg **(D)** 0

Centre of Mass

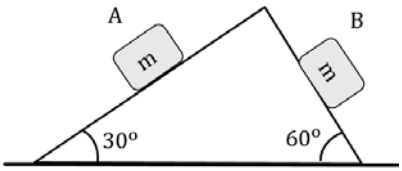
Q.9 A circular plate of uniform thickness has a diameter of 28 cm. A circular portion of diameter 21 cm is removed from the plate as shown. Ois the center of mass of the complete plate. The position of center of mass of the remaining portion will shift towards left from O by.



(A) 5 cm **(B)** 9cm **(C)** 4.5cm **(D)** 5.5cm

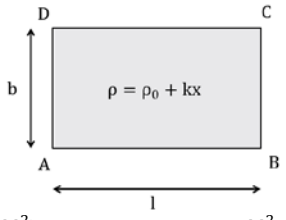
Centre of Mass

Q.10 Two blocks A and B each of equal mass m are released from the top of a smooth fixed wedge as shown in figure. Find the magnitude of acceleration of COM of the two blocks.
(A) 2g **(B)** g **(C)** $\frac{2g}{3}$ **(D)** $\frac{g}{2}$



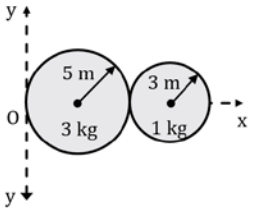
Q.11 A system contains n concentric hollow spheres of different materials and different radii. Then the position of the COM of the system will depend on
(A) Densities of materials only
(B) Densities of materials and radii of spheres only
(C) Densities of materials, radii and number of spheres
(D) None of these

Q.12 A rectangular lamina ABCD has same density along side AD but has increasing density along side AB. The density along side AB is given as $\rho = \rho_0 + kx$ where ρ_0 and k are constants and x is distance from the side AD. Find the distance of COM from side AD.



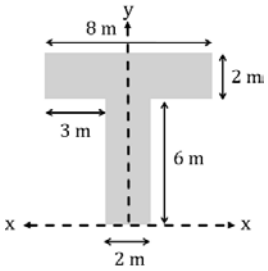
(A) $\frac{2(\rho_0+kl)}{3}$ **(B)** $\frac{(3\rho_0+2kl^2)}{6\rho_0+3kl}$ **(C)** $\frac{2kl^2}{\rho_0+3kl}$ **(D)** $\frac{2\rho_0+kl^2}{(6\rho_0+2kl)}$

Q.13 Two discs of radii 5 m and 3 m are joined together along their circumference as shown in the figure below. Find the centre of mass of the system of two discs



(A) (6,0)m **(B)** (5,0)m **(C)** (7,0)m **(D)** (4,0)m

Q.14 Find the position of the centre of mass of T − shaped lamina of negligible thickness as shown in figure. Assume the origin to be at the intersection of axes and take the mass density of the lamina, $\sigma = 1\ kg/m^2$.

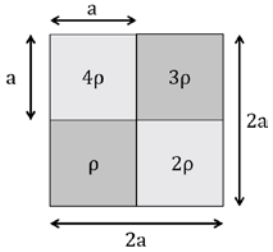


(A) (0,6.5)m **(B)** (0,6)m **(C)** (0,5.28)m **(D)** (0,4.55)m

Q.15 Four spheres of radii R, 2R, 2R and 3R respectively, are placed such that their respective centres lie at $x = 2\ m,\ x = 6\ m, x = 10$ and $x = 20$ m respectively. If density of each sphere is the same, then find the x −coordinate of COM of the system of spheres.

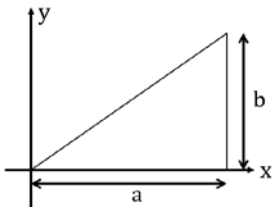
(A) $x = 10m$ **(B)** $x = 16m$ **(C)** $x = 16.44m$ **(D)** $x = 15.22m$

Q.16 A square lamina is made up of a combination of 4 smaller square plates. The density of plates are different and the whole arrangement is shown in the figure. Find out the distance of COM of given system from its geometric centre.



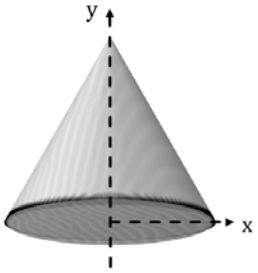
(A) 0.2a **(B)** $\sqrt{0.2}$a **(C)** 0.4a **(D)** $\sqrt{0.4}$a

Q.17 A uniform lamina in the shape of a right-angled triangle is shown in the figure. Find the co-ordinates of COM of the lamina. Assume the origin to be at the intersection of x and y axes.



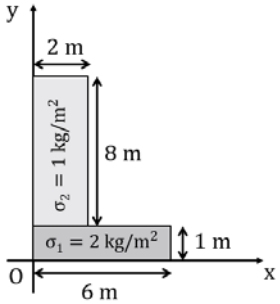
(A) $(\frac{a}{3},\frac{b}{3})$ **(B)** $(\frac{2a}{3},\frac{2b}{3})$ **(C)** $(\frac{2a}{3},\frac{b}{3})$ **(D)** $(\frac{a}{3},\frac{2b}{3})$

Q.18 1000 m^3 of sand is being poured on the ground. It accumulates on the ground in the shape of a conical pyramid. If the radius of the base of pyramid is 5 m, where the centre of mass of the pile of is sand located?



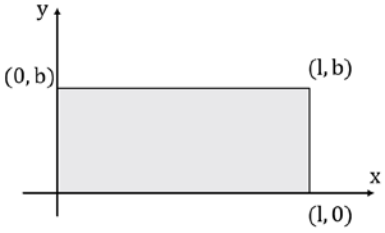
(A) $\frac{90}{\pi}$ m from the centre of the base **(B)** $\frac{30}{\pi}$ m from the centre of the base
(C) $\frac{12}{\pi}$ m from the top of the pyramid **(D)** $\frac{3}{\pi}$ m from the top of the pyramid

Q.19 Two uniform rectangular plates having mass density (mass/area) 2 kg/m^2 and 1 kg/m^2 are joined together to form the L − shaped lamina as shown in the figure. Find the coordinates of centre of mass of the L − shaped lamina.



(A) $(\frac{17}{11},\frac{83}{22})$m **(B)** $(\frac{26}{7},\frac{43}{14})$m **(C)** $(\frac{26}{7},\frac{43}{14})$m **(D)** $(\frac{13}{7},\frac{43}{14})$m

Q.20 A rectangular lamina in the x − y plane is shown below:
Density of this lamina is constant along x −axis and varies along y −axis. If the variation in density is given as $\rho(y) = 16\rho_o y^2$, then the coordinates of COM will be



(A) $x_{COM} = \frac{l}{2}$ **(B)** $y_{COM} = \frac{b}{2}$ **(C)** $x_{COM} = \frac{l}{4}$ **(D)** $y_{COM} = \frac{3b}{4}$

ANSWER KEY

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