CHAPTER: 1 (FORCE)

SECTION :B (CENTRE OF GRAVITY)

Centre of Gravity:

The centre of gravity of a body is the point about which the algebraic sum of moments of weights of all the particles constituting the body is zero.

The entire weight of the body can be considered to act at this point, how so ever the body is placed

The position of the centre of gravity of a body of given mass depends on its shape i.e., on the distribution of mass. It is not necessary that the centre of gravity will always be within the material of the body.

Importance of determining the center of gravity location

The center of gravity location has several unique properties:

- ***An object in space rotates about its center of gravity.***
- ***A force applied to the center of gravity causes pure translation.***

Therefore the location of center of gravity is an essential parameter to determine the flight characteristics of an object. Controlling the flight of an object necessitates good knowledge of its center of gravity location.

For example, aligning the direction of thrust of a rocket motor so that it pushes exactly through the center of gravity of the rocket is essential to achieving a straight flight.

Exercise Ex. 1B

Question 1
Define the term 'centre of gravity of a body'.

Solution 1
Centre of gravity is the point about which the algebraic sum of moments of weights of particles constituting the body is zero and the entire weight of the body is considered to act at this point.

Question 2
Can the centre of gravity of a body be situated outside its material of the body? Give an example.

Solution 2
Yes, the centre of gravity can be situated outside the material of the body. For example, centre of gravity of ring.

Question 3

State factor on which the position of centre of gravity of a body depend? Explain your answer with an example.

Solution 3

The position of centre of gravity of a body of given mass depends on its shape i.e., on the distribution of mass in it. For example: the centre of gravity of a uniform wire is at its mid-point. But if this wire is bent into the form of a circle, its centre of gravity will then be at the centre of circle.

Question 4

What is the position of centre of gravity of a :
(a) rectangular lamina
(b) cylinder ?

Solution 4

The position of centre of gravity of a
(a) rectangular lamina is at the point of intersection of its diagonals.
(b) cylinder is at the mid point on the axis of cylinder.

Question 5

At which point is the centre of gravity of situated in:

(a) A triangular lamina and
(b) A circular lamina?

Solution 5

(a)Centre of gravity of a triangular lamina is situated at the point of intersection of its medians.
(b)Centre of gravity of a circular lamina is situated at the centre of circular lamina.

Question 6

Where is the centre of gravity of a uniform ring situated?

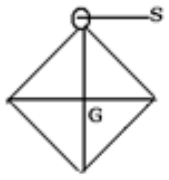
Solution 6

Centre of gravity of a uniform ring is situated at the centre of ring.

Question 7

A square card board is suspended by passing a pin through a narrow hole at its one corner. Draw a diagram to show its rest position. In the diagram mark the point of suspension by the letter S and centre of gravity by the letter G.

Solution 7



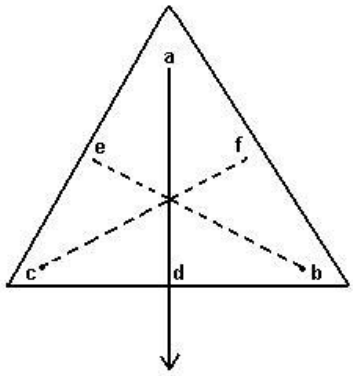
A square card board in rest position with G as centre of gravity and S as point of suspension.

Question 8

Explain how will you determine experimentally the position of centre of gravity for a triangular lamina (or a triangular piece of card board).

Solution 8

Take a triangular lamina. Make three fine holes at a, b, c near the edge of triangular lamina. Now suspend the given lamina along with a plumb line from hole 'a'. Check that the lamina is free to oscillate about the point of suspension. When lamina has come to rest, draw straight line ad along the plumb line. Repeat the experiment by suspending the lamina through hole 'b' and then through hole 'c' for which we get straight lines be and cf respectively. It is noticed that the lines ad, be and cf intersect each other at a common point G which is the position of centre of gravity of triangular lamina i.e. the point of intersection of medians.



Question 9

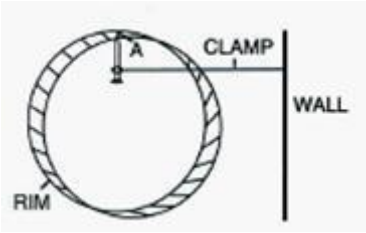
State whether the following statement is true or false.
(i) 'The position of centre of gravity of a body remains unchanged even when the body is deformed'.
(ii) 'The centre of gravity of a freely suspended body always lies vertically below the point of suspension'.

Solution 9

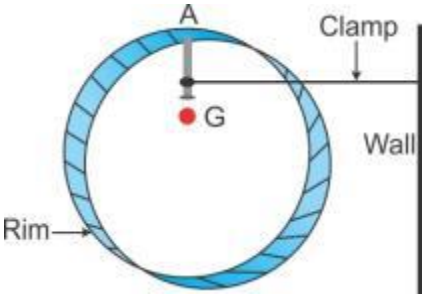
(i) False. The position of centre of gravity of a body of given mass depends on its shape i.e., on the distribution of mass in it.
(ii) True.

Question 10

A uniform flat circular rim is balanced on a sharp vertical nail by supporting it at point A, as shown in Fig. 1.42. Mark the position of centre of gravity of the rim in the diagram by the letter G.

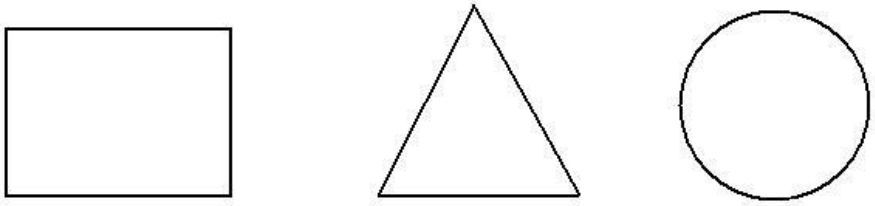


Solution 10

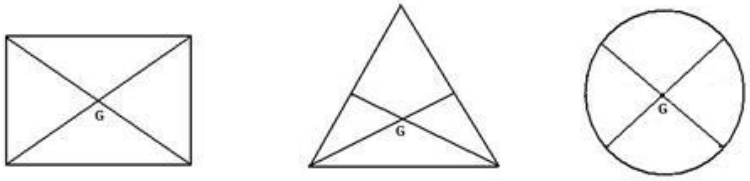


Question 11

Figure shows three pieces of card board of uniform thickness cut into three different shapes. On each diagram draw two lines to indicate the position of centre of gravity G.



Solution 11



Question 12

The centre of gravity of a uniform ball is
(a) At its geometrical centre
(b) At its bottom
(c) At its topmost point
(d) At any point on its surface

Solution 12

At its geometrical centre

Question 13

The centre of gravity of a hollow cone of height h is at distance x from its vertex where the value of x is:

a. h/3
b. h/4
c. 2h/3
d. 3h/4

Solution 13

The centre of gravity of a hollow cone is at a height h/3 from the base. Hence, from the vertex the height is h - h/3 = 2h/3.
Hence, the correct answer is option c.