Force

1. **What Is Force?**

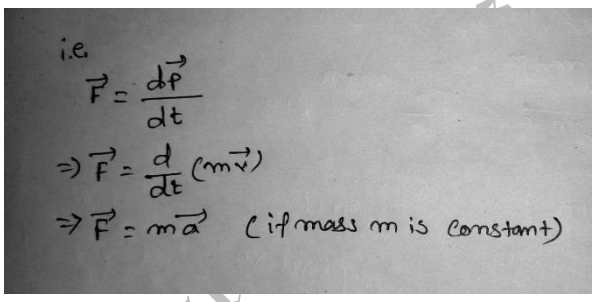
   Ans. Force is an external agent capable of changing the state of rest or motion of a particular body.
   It has a magnitude and a direction. The direction towards which the force is applied is known as the **direction of the force**, and the application of force is the point where force is applied.
   It is a **Vector Quantity.**

2. **What Happen When Force is applied on a Body?**

   Ans. When the Force is applied on a rigid body can cause only **motion** in it.
   When applied on a non-rigid body can cause both a change in its size or **shape and motion** in it.

3. **How can we Define Force?**

   Ans. Force is applied on a body is defined as the rate of change in its liner momentum.



4. **What are the Unit of Force?**
   Ans. SI unit of Force Newton (N) or Kilogram-Force (Kgf)
   Where 1 Kgf= g N

5. **What happen when a rigid body is acted upon by a force?**
   Ans. A rigid body is acted upon by a force, can have two kinds of motion:
   a. Liner or translation motion
   b. Rotational Motion

6. **What is Linear or Translational Motion?**
   Ans. When a force acts on a stationary rigid body which is free to move, the body starts moving in a straight path in the direction of force. This is called the Linear or Translational Motion.

7. **What is the Rotational Motion?**
   Ans. If the body is pivoted at a point and the force is applied on the body at a suitable point, it rotates the body about the axis passing through the pivoted point. This turning effect of the force and the motion of the body is called the Rotational Motion.

8. **What is called Moment of Force?**
Ans. The moment of force or Torque is equal to the product of the magnitude of the force and the perpendicular distance of the line of action of the force from the axis of rotation.

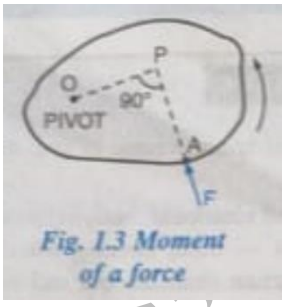


Fig. 1.3 Moment of a force

Let a body is pivoted at a point O. If a force F is applied horizontally on the body with its line of action in the direction AP as shown in the figure. The force us unable to produce linear motion of the body in its direction because the body in its direction because the body is not free to move, but this force turns the body about the vertical axis passing through the point O in the direction shows by the arrow in the figure. Moment of Force about this axis passing through the point O
= **Force × Perpendicular Distance of force the point O**
= **F× OP**

9. **What are the units of Moment of Force?**
Ans. SI Unit of Moment of Force: **Newton × Metre.** And is denoted by **Nm.**
The CGS Unit **Dyne × Cm.**

1 Nm= 10^7 Dyne Cm

** If Force is measured in Gravitational Unit, then
SI Unit of Moment of Force: **Kgf × m**
CGS Unit of Moment of Force: **gf × cm.**

1 Kgf × m = 9.8 Nm

1 gf × cm = 980 Dyne cm

10. **How can we maximise the Turning Effect?**
Ans. For producing maximum turning effect on a body by a given force, would be to increase the distance from the axis of rotation where the force would act.

11. **What is the Turning Effect of the body?**
Ans. the turning effect of the body about an axis is due to moment of force applied of the body.

12. **On which factors the turning effect of force on a body depends?**
Ans. The turning effect of a force on a body depends on the following two factors:
a. The magnitude of the force applied and
b. The perpendicular distance of the line of action of the force from the axis of rotation or the Pivoted point.

13. **What are Clockwise and Anti Clockwise Moment?**
Ans. If the effect of moment of force on the body is to turn Clockwise, the moment of Force is called the Clockwise Moment of Force. And it is taken Negative.
If the effect of moment of force on the body is to turn Anti-Clockwise, the moment of Force is called the Anti-Clockwise Moment of Force. And it is taken Positive.

14. **What are the differences between Clockwise and Anticlockwise Moment?**

Ans.

Clockwise Moment	Anti-Clockwise Moment
Due to moment of force the body turns Clockwise	Due to moment of force the body turns Clockwise
It is taken Negative.	It is taken Positive.
The direction along the axis of rotation is Outwards.	The direction along the axis of rotation is Inwards.

15. **Why is it easier to open a door by applying the force at the free end of it?**

Ans. It is easier to open a door by applying the force at the free end of it because larger the perpendicular distance, less is the force needed to turn the body.

16. **The stone of hand flour grinder is provided with a handle near its rim. Give a reason.**

Ans. The stone of hand flour grinder is provided with a handle near its rim so that it can be rotated easily about the iron pivot at its centre by a small force applied at the handle.

17. **It is easier to turn the steering wheel of a large diameter than that of a small diameter. Give reason.**

Ans. It is easier to turn the steering wheel of a large diameter than that of a small diameter because less force is applied on steering of large diameter which is at a large distance from the centre of rim.

18. **A spanner (or wrench) has a long handle. Why?**

Ans. A spanner (or wrench) has a long handle to produce larger turning moment so that nut can easily be turned with a less force.

19. **A jack screw is provided with a long arm. Explain why?**

A jack screw has a long arm so that less effort is required to rotate it to raise or lower the jack, which is used to lift a heavy load like a vehicle.

20. **What is Couple?**

Ans. A couple is a pair of forces, equal in magnitude, oppositely directed, and displaced by perpendicular distance or moment.

The perpendicular distance between the two force is called the **Couple Arm.**

21. Define the Moment of Couple.

Ans. Ans. Let AB is a bar which is pivoted at a point O. At the ends A and B, two equal and opposite force each of Magnitude F, are applied. The perpendicular distance between the two force is AB (d) which is called the Couple Arm.

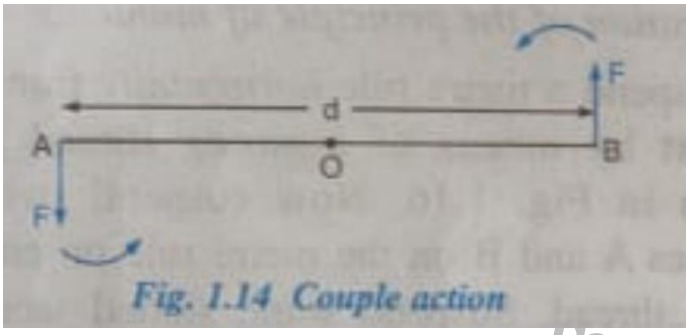


Fig. 1.14 Couple action

The two Forces cannot produce translational motion as their resultant sum any direction is Zero, but each force has the turning effect on the bar in the same direction. Thus, the two forces together form a couple which rotates the bar about the point O.

In this figure the two forces rotate the bar anticlockwise.

Now Moment of Force F at the end A= F×OA (Anticlockwise)

Moment of Force F at the end of B= F× OB (Anticlockwise)

So the total moment of Couple = (F×OA) + (F× OB)

= F× (OA+OB)

= F× AB

= F× d (Anticlockwise)

So

Moment of Couple= Either Force× Perpendicular Distance between the two forces

22. What is called Equilibrium?

Ans. When a number of forces acting on a body produce no change in its state of rest or of linear or rotational motion, the body is said to be in equilibrium.

23. How many types of equilibrium?

Ans. Equilibrium is of two kinds,

1. Static Equilibrium
2. Dynamic Equilibrium

24. What is Static Equilibrium?

Ans. When a body remains in the state of rest under the influence of several forces, the body is in Static Equilibrium.

Example: If a Body lying on the table top is pulled by a force F to its left and by an equal force F to its right, the body does not move. The reason is that the applied force is equal and opposite along the same line, so they balance each other. Hence the body remains rest.

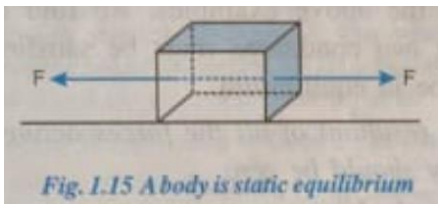


Fig. 1.15 A body is static equilibrium

25. What is Dynamic Equilibrium?

Ans. When a body remains in the same state of motion under the influence of the several force, the body is said to be in Dynamic Equilibrium.

Example: An aeroplane moves at a constant height when upward lift on it balance its weight downwards.

Ex:

26. Which conditions are essential for Equilibrium?

Ans. Two conditions must be satisfied for a body to be in equilibrium.

a. The resultant of all the force, acting on the body should be zero.
b. The algebraic sum of moment of all the forces acting on the body about the point of rotation should be zero.
   i.e. The sum of the anticlockwise moment about the axis of rotation is equal to the sum of the clockwise moment about the axis of rotation.

27. What is Principle of Moments?

Ans. According to Principle of Moments if the algebraic sum of moment of all the forces acting on the body about the point of rotation should be zero the body is in equilibrium.

According to Principle of Moments in equilibrium,

Sum of the anticlockwise moment about the axis of rotation = Sum of the clockwise moment about the axis of rotation.

28. A body is acted upon by two forces each of magnitude F, but in opposite directions. State the effect of the forces if
(a)both forces act at the same point of the body.
(b)the two forces act at two different points of the body at a separation r.

Ans. (a)Resultant force acting on the body = F-F=0 moment of forces = 0 i.e., no motion of the body

(b)The forces tend to rotate the body about the mid-point between two forces, Moment of forces= Fr

29. What is Centre of Gravity?

Ans. 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, howsoever the body is placed.

It is Denoted by **"G".**

30. Write some properties of Centre of Gravity.

Ans. the properties of Centre of Gravity are

a. The position of Centre of Gravity of a body for a given mass depends on its shape, i.e. on the deformation of mass in it. It changes if the body is deformed.
b. It is not necessary that the Centre of Gravity always be within the material of the body
   Ex. The CG of ring or a hollow sphere lies at its centre where there is no material.
c. By the concept of centre of gravity, a body of weight W can be considered as a point particle of weight W at its centre of gravity.

31. How can we increase the stability of a Body?

Ans. For the stable equilibrium of a body, the centre of gravity must be as low as possible. It must be above the base, near the geometrical centre of the body.

32. Find the Centre of Gravity of Some regular uniform object.

Ans

Object	Position of Centre of Gravity
Rod	Mid-Point of the Rod
Circular Disk	Geometric Centre
Solid or Hollow Sphere	Geometrical Centre
Solid or Hollow Cylinder	Mid-point on the axis of the cylinder.
Solid Cone	At a height h/4 from the base on its axis
Hollow Cone	At a height h/3 from the base on its axis
Cylindrical Ring	Centre of the Ring
Triangular Lamina or Scalene Triangle	Point of intersection of the medians.
Parallelogram, Rectangular Lamina, Square and Rhombus	Point of intersection of the diagonals.