12/9/21

ENGINEERING MECHANICS

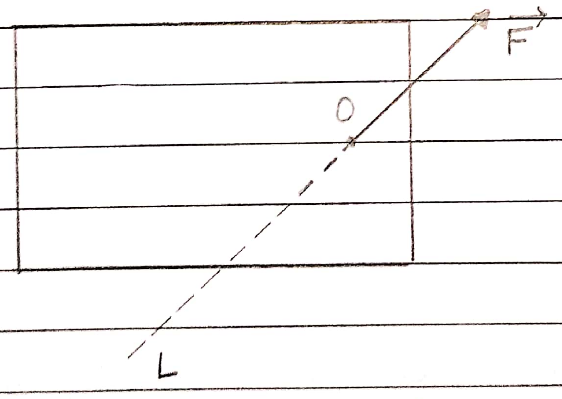
Module - 1 - Short questions

Q.1. State the principle of "Transmissibility of Force".

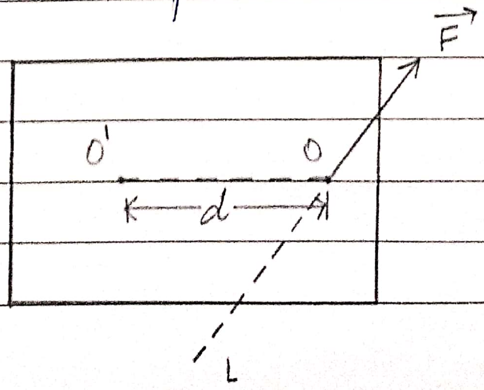
→ The principle of transmissibility of force states that "the point of application of force may be moved anywhere along the line of action of the force without changing the external reaction forces on a rigid body"

Q.2 Prove that a given force F applied the a body at any point A can be replaced by an equal force applied at another point B and a couple.

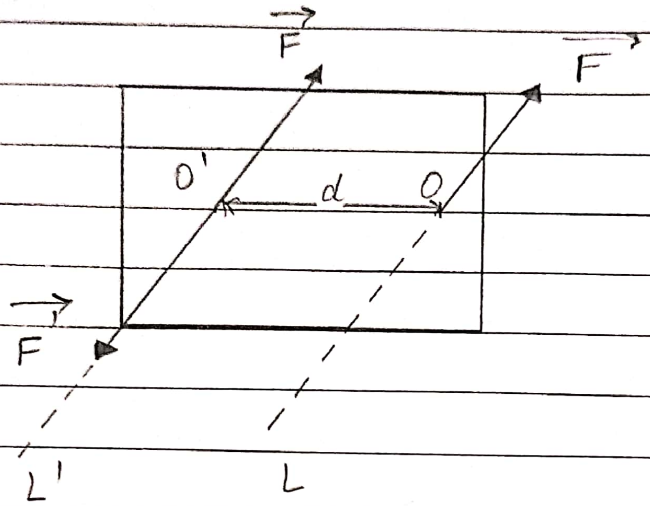
→ Consider an object given below: Consider a force F acting along direction and line of action L



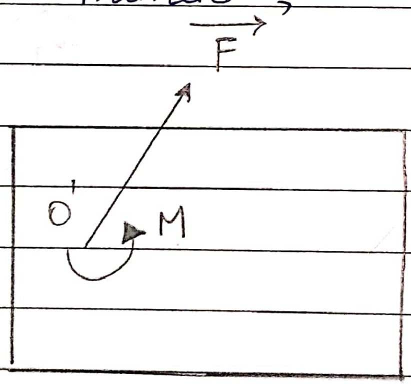
Consider another point O' at a distance 'd' from O.



Let us add 2 Forces at point O'
F and F', both equal and opposite.
∴ No net force is added.



But we now have 2 Forces, equal in magnitude F acting at O along L, and F' acting at O' along L', separated by a distance 'd'. Therefore, we now have a moment, (M)



where $\boxed{M = F \cdot d}$

∴ We have replaced a Force acting on O with a couple M and another Force acting at O'.

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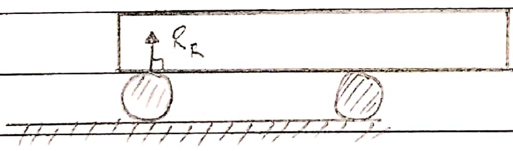
Q.3. Explain the term support reactions. Explain the different types of supports.

→ **Support Reaction :**

When a number of forces are acting on a body, and that body is supported by another body, the second body exerts a force on the first body known as a reaction Force. The second body is called the support and the forces are called support reactions.

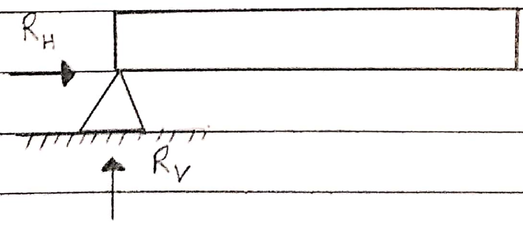
There are 3 Types of Support Reactions :

① **Roller Support :** End of Beam is supported by roller, There is only 1 vertical Reaction.

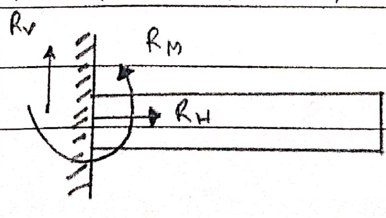


eg. Skateboard.

② **Hinged Support :** Resists all forces but cannot resist Moments. There will be 2 reactions.

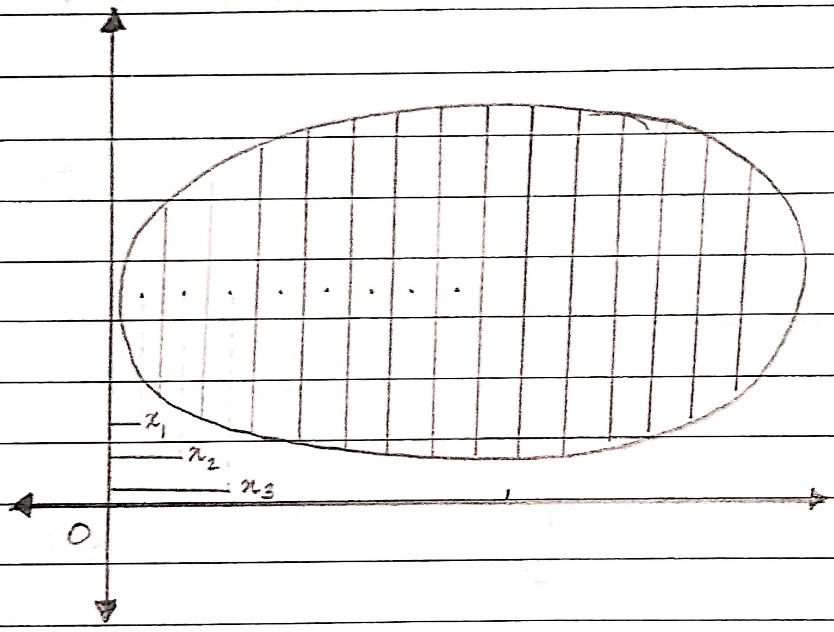


③ **Fixed Support :** Resists all forces as well as moment. So there are 3 reactions. Horizontal, vertical and a Moment



Q.4 Derive an expression for the centre of gravity of a plane area using method of moments.

→ Consider a body of Mass M. Divide the body into smaller parts along the x and y axes, as shown. Let the co-ordinates of their centre of gravity be (x_1, y_1), (x_2, y_2) (x_3, y_3) ... (x_n, y_n) from the origin. Their masses are $m_1, m_2, m_3 \cdots m_n$



Let $\bar{x}$ and $\bar{y}$ be the co-ordinates of the centre of gravity of the object of Mass M.

where $M = m_1 + m_2 + m_3 \cdots m_n = \Sigma m_n$

∴ Moment along x & y

~~Mx~~ $M \cdot \bar{x}$

But according to principle of Moments, $M \cdot \bar{x}$ can be represented as the sum of smaller moments m_1x_1, m_2x_2, m_3x_3 ·· m_nx_n

$$\therefore \quad M \cdot \bar{x} = m_1x_1 + m_2x_2 + m_3x_3 \cdots m_nx_n$$

$$M\bar{x} = \Sigma m_nx_n$$

$$M \cdot \bar{x} = \sum m_n x_n$$

$$\boxed{\bar{x} = \frac{\sum m_n x_n}{\sum m_n}}$$

Similarly

$$\boxed{\bar{y} = \frac{\sum m_n y_n}{\sum m_n}}$$

Q.5 A number of forces are acting on a body. What are the conditions such that the body is in equilibrium?

ans. For a body to be in equilibrium, 2 conditions must be followed.

(1) Translation equilibrium must be met "when the sum of all external forces acting on the body is zero"

That is $\boxed{\sum F_{ext} = 0} = \sum F_x = \sum F_y = \sum F_z = 0$

(2) Rotational Equilibrium must be met "when the sum of all external moments or Torques acting on the body is zero"

That is $\boxed{\sum M_{ext} = 0}$

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