Equilibrium

Starter

1. **(Review of last lesson)** A horizontal uniform rod AB of length 12 m and mass 1.6 kg is acted upon by an upward vertical force of 23 N at B. Find the sum of the moments about A.

Notes

For a body in equilibrium there is no resultant force in any direction. It means that:

- the sum of the forces **in any direction** is zero
- the sum of the moments ***about any point*** is zero

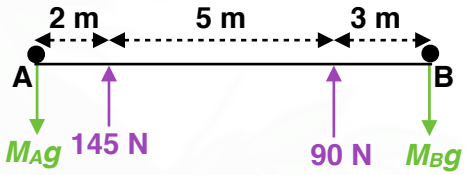
N.B. The **upward force** is provided either by the **normal reaction forces** at the supports or the **tension** in the strings attached to the beam.

When solving questions:

1. ***Take moments*** about a suitable point, usually ***where one of the forces is acting.***
2. ***Resolve vertically.***

N.B. The "about a suitable point" is important as it allows us to take moments about any point i.e. at the point where one of the forces acts, so this can eliminate one of the unknowns. ***Always*** draw a large, clear diagram.

E.g. 1 The diagram shows a light rod AB of length 10 m. Given that the rod is in equilibrium, find M_A and M_B.



Working: An unknown force acts through A so take moments about A.

↻ about A:
$$M_B g \times 3 = 145 \times 2 + 90 \times 7$$
$$M_B = \frac{145 \times 2 + 90 \times 7}{3g}$$
$$M_B = 9.39 \text{ kg}$$

$R(\uparrow)$:
$$M_A g + M_B g = 145 + 90$$
$$M_A g + 9.39g = 145 + 90$$
$$M_A g = \frac{145 + 90 - 9.39g}{g}$$
$$M_A = 14.6 \text{ kg}$$

E.g. 2 A 6 m long uniform beam AB of weight 40 N is supported at A by a vertical reaction R. AB is held horizontal by a vertical wire attached 1 m from the other end. A particle of weight of 30 N is placed 2 m from the support A. Find the tension T in the wire and the force R.

E.g. 3 A light rod AB, of length 4 m, supports an object of weight 4 N at its midpoint. It rests in equilibrium in a horizontal position on vertical supports at C and D, where $AC = 1$ m and $AD = 3.5$ m. Find the magnitude of the reaction forces at C and D.

Video: Horizontal beam in equilibrium

Horizontal beam in equilibrium EQ

Solutions to Starter and E.g.s

Exercise
p513 22B Qu 1i, 2i, 3-12

Summary
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- the sum of the moments ***about any point*** is zero

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