

3.2 Equilibrium of a rigid body

Name: _____ Class: _____ Date: _____

Total: 15 marks

KEY WORDS centre of mass • equilibrium • toppling • sliding
• moment

Objective

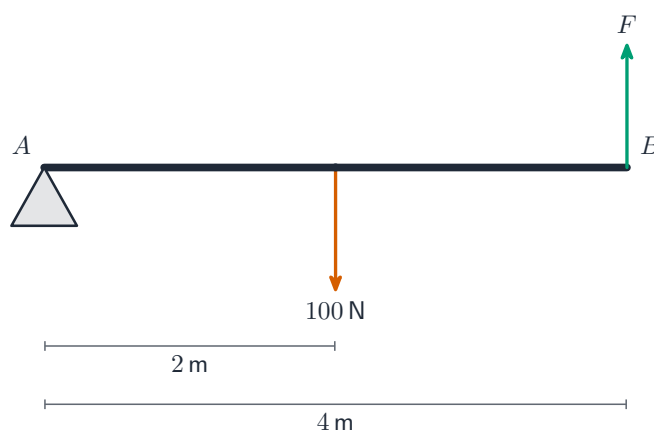
Build the skills to answer exam questions on the **equilibrium of a rigid body** – **moments**, the **centre of mass**, and conditions for **toppling** or **sliding**. Take $g = 10 \text{ m s}^{-2}$.

You must be able to:

- take moments about a point (force $\times$ perpendicular distance)
- apply the two equilibrium conditions (forces and moments both balance)
- decide whether a body topples or slides first

1 Key knowledge and worked examples

■ Taking moments



Taking moments about the pivot A balances the turning effects

Uniform beam AB, length 4 m, weight 100 N, pivot at A, force F at B:
moments about A $\rightarrow F \times 4 = 100 \times 2 \Rightarrow F = 50 \text{ N}$.

■ **Key knowledge: Toppling or sliding**

Toppling begins when the weight line passes through the supporting edge. Sliding begins when the required friction reaches μR ; compare the thresholds.

■ **Worked example: Toppling or sliding**

A block on an incline has base length 0.60 m along the slope and height 0.80 m perpendicular to it. About the downhill edge, toppling occurs at $\tan \theta = 0.60/0.80 = 0.75$. With $\mu = 0.50$, sliding starts at $\tan \theta = 0.50$, so sliding occurs first as the slope increases.

2 Practice

2.1 A force of 20 N acts 3 m from a pivot, at right angles. Find its moment. [2]

2.2 State the two conditions for a rigid body to be in equilibrium. [2]

3 Exam-style questions

3.1 The moment of a force about a point is force multiplied by: [1]

- ☐ **A** time
B the perpendicular distance
C mass
D velocity

3.2 A uniform ladder AB of weight 200 N and length 6 m rests with A on rough ground and B against a smooth vertical wall, at 60° to the horizontal.

(a) By taking moments about A , find the reaction at the wall. [4]

(b) Hence find the friction force at the ground. [2]

3.3 A uniform rod AB of length 2 m and weight 40 N rests horizontally on supports at A and at C , where C is 1.5 m from A . Find the reaction at each support. [4]
