

3.2 Equilibrium of a rigid body

Name: _____ Class: _____ Date: _____

Total: 15 marks

Objective

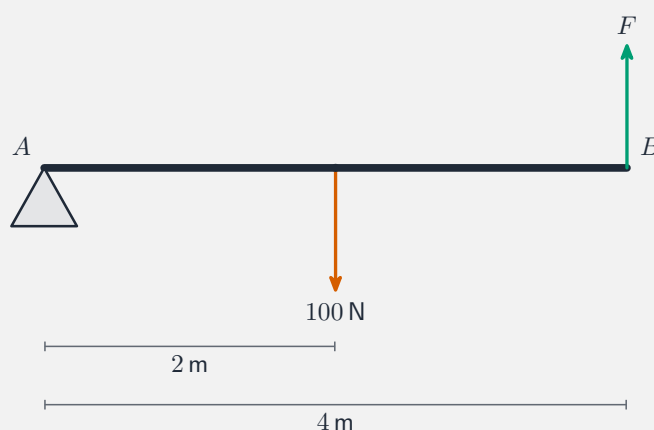
Build the skills to answer exam questions on the **equilibrium of a rigid body** 刚体平衡—**moments** 力矩, the **centre of mass** 质心, and conditions for **toppling** 翻倒 or **sliding** 滑动. Take $g = 10 \text{ m s}^{-2}$.

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 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 $\rightarrow F \times 4 = 100 \times 2 \Rightarrow F = 50 \text{ N}$.

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
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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]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **3.2 Equilibrium of a rigid body** past-paper sheet in the Library, or try these in **Practice mode**:

- 9231/31 N25 —Q5 (moments / equilibrium)
- 9231/32 N25 —Q3 (rigid body)
- 9231/34 N25 —Q3 (equilibrium)

Solutions

2.1 moment = $20 \times 3 = 60$ N m.

2.2 the resultant force is zero; the resultant moment about any point is zero.

3.1 B. Moment = force $\times$ perpendicular distance.

3.2 (a) wall reaction S is horizontal at B ; weight 200 N acts at the midpoint (3 m along). Moments about A : $S \times 6 \sin 60^\circ = 200 \times 3 \cos 60^\circ$; $S \times 5.196 = 300 \Rightarrow S = 57.7$ N.

(b) horizontal equilibrium: friction = $S = 57.7$ N.

3.3 moments about A : $R_C \times 1.5 = 40 \times 1 \Rightarrow R_C = 26.7$ N; vertical: $R_A + R_C = 40 \Rightarrow R_A = 13.3$ N.