# Moments 3ii

A Level

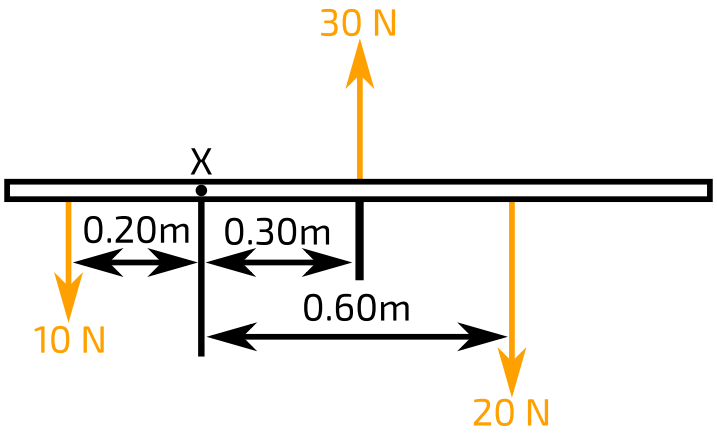


**Figure 1:** Three forces acting on a rod.

**Figure 1** shows three forces acting on a rod.

## Part A Moments around $X$

Find the clockwise moment about point $X$.

Find the sum of the two anticlockwise moments about point $X$.

Is the rod in equilibrium? If not, which direction will it rotate?

- Yes
- It's impossible to tell whether it is in equilibrium
- No, and it will rotate clockwise
- No, and it will rotate anticlockwise
- No, but it is impossible to tell which way it will rotate

## Part B Additional force

An additional force of $4\,\mathrm{N}$ can be applied so that the system is then in equilibrium.

Find the distance from $X$ of the line of action for the additional force. The line of action must be applied perpendicular to the length of the rod.

Adapted with permission from UCLES, A Level, January 2011, OCR Physics A G481, Question 6

# Moments 4ii

A Level

A concrete paving slab has mass $45\,\mathrm{kg}$ and dimensions $0.600\,\mathrm{m} \times 0.600\,\mathrm{m} \times 0.050\,\mathrm{m}$. **Figure 1** shows the paving stone in equilibrium.

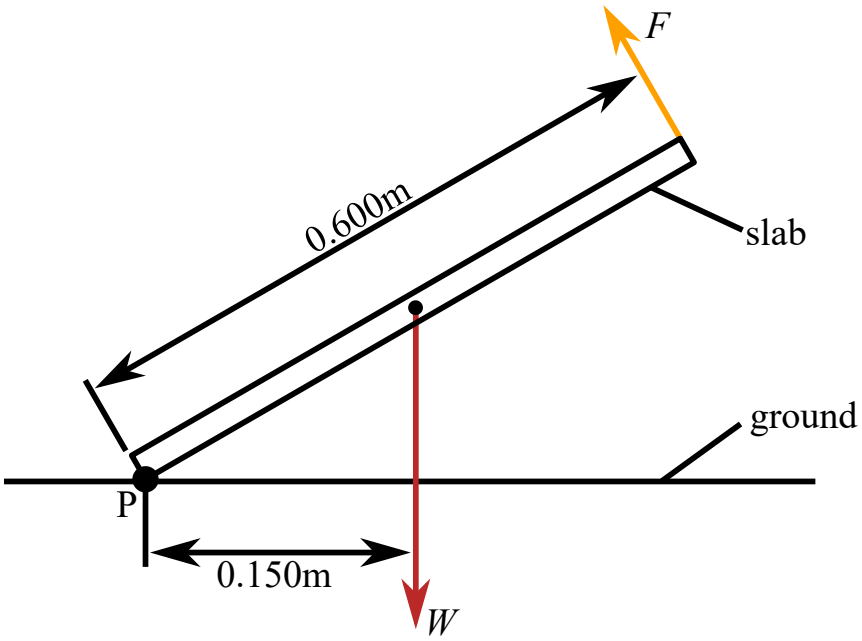


**Figure 1:** A concrete paving slab in equilibrium.

## Part A Magnitude of $F$

Two forces acting on the slab are shown. The weight of the slab is $W$, which is shown acting downwards from the centre of the slab. The force $F$ is applied at right angles to the end of the slab.

By taking moments about $P$, determine the size of the force $F$.

## Part B Assumptions necessary

Which of these assumptions are used in part A? Choose all options that apply.

- [ ] We assumed that the ground is smooth, so that there is no friction force between the slab and the ground to consider.
- [ ] We assumed that the force F is provided by a string that is light, so that there is no mass associated with the force F to consider.
- [ ] We assumed that the mass is uniformly distributed throughout the slab so the weight is acting through the geometrical centre of the slab (ie, the centre of mass).

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Adapted with permission from UCLES, A Level, June 2010, OCR Physics A G481, Question 6

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# Moments 5i

A Level

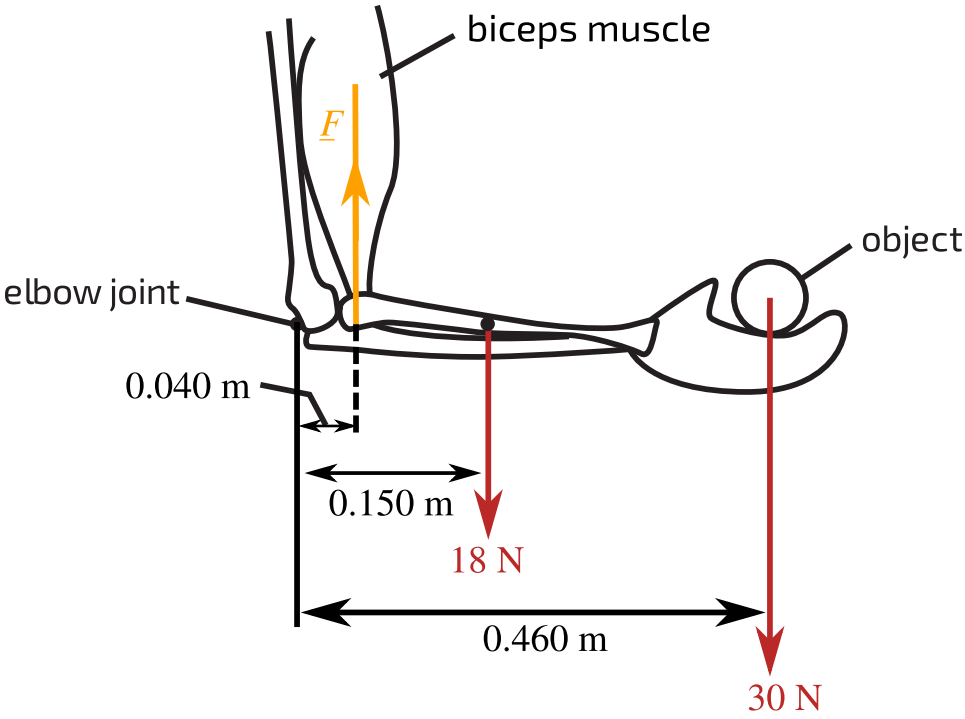


**Figure 1:** A human arm lifting an object.

**Figure 1** shows a human arm lifting an object. The lower arm is horizontal and its centre of gravity is $0.150\,\mathrm{m}$ from the elbow joint. The weight of the lower arm is $18\,\mathrm{N}$. The biceps muscle exerts a vertical force $F$ on the arm. The horizontal distance between the elbow joint and the point of attachment of the muscle to the lower arm bone is $0.040\,\mathrm{m}$. The weight of the object held in the hand is $30\,\mathrm{N}$ and its centre of gravity is $0.460\,\mathrm{m}$ from the elbow joint. The arm is in equilibrium.

## Part A Total clockwise moment

Calculate the total clockwise moment about the elbow joint correct to 3 significant figures.

## Part B Further from body

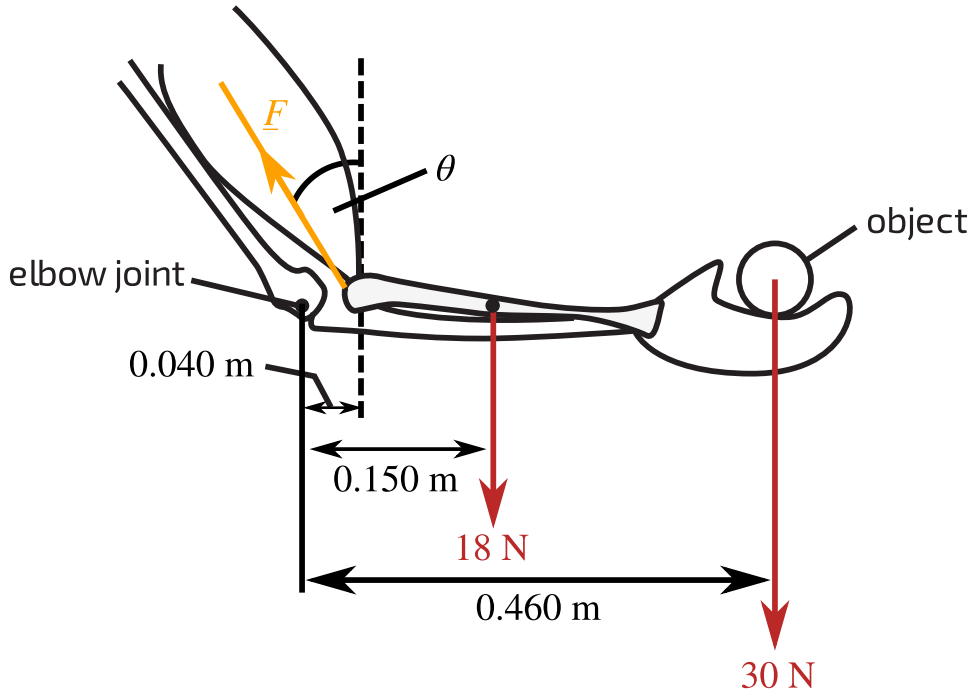


**Figure 2:** An arm holding a ball with the lower arm moved away from the body.

As the lower arm is moved away from the body, the force $F$ exerted by the biceps muscles acts at an angle $\theta$ to the vertical as shown in **Figure 2**.

The lower arm remains horizontal and in equilibrium. Describe and explain what happens to each of the following quantities as the angle $\theta$ is increased:

As $\theta$ increases, what happens to the anticlockwise moment about the elbow joint?

- It increases
- It decreases
- It stays the same

As $\theta$ increases, what happens to the magnitude of the force $F$?

- It decreases
- It increases
- It stays the same

Used with permission from UCLES, A Level, January 2012, OCR Physics A, Question 4

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# Moments 5ii

A Level

**Figure 1** shows a kitchen cupboard securely mounted to a vertical wall. The cupboard rests on a support at $A$.

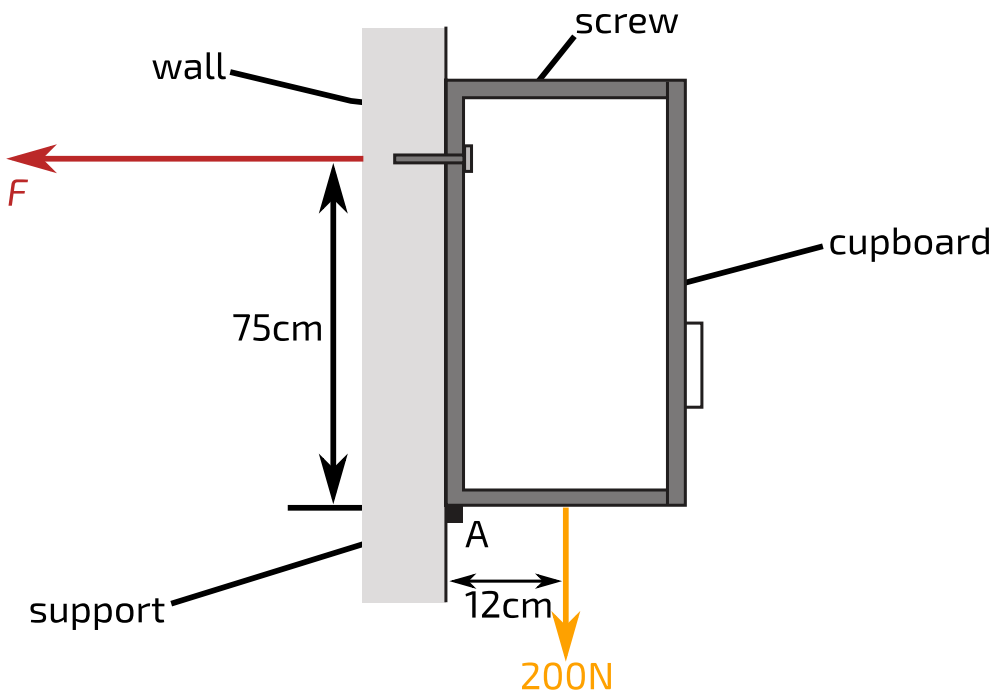


**Figure 1:** The forces acting on a cupboard.

The total weight of the cupboard and its contents is $200\,\mathrm{N}$. The line of action of its weight is at a distance of $12\,\mathrm{cm}$ from $A$. The screw securing the cupboard to the wall is at a vertical distance of $75\,\mathrm{cm}$ from $A$.

## Part A Determine $F$

The direction of the force $F$ provided by the screw on the cupboard is horizontal as shown in **Figure 1**. By taking moments about $A$, determine the value of $F$.

## Part B Screw secured closer

State and explain how your answer to the previous question would change, if at all, if the same screw was secured much closer to $A$.

Let us represent the distance from the line of action of $F$ to the screw by $d$. The clockwise moment is [ ], so the anticlockwise moment is also [ ] as the system must stay in equilibrium. Hence, we have the equation [ ].

Therefore, $F \propto$ [ ], meaning that as the distance $d$ [ ] (ie, if the screw is secured closer to $A$), the force [ ].

Items:

$12\,\mathrm{N\,m}$ | $24\,\mathrm{N\,m}$ | $2.4\,\mathrm{N\,m}$ | $Fd = 24$ | $\frac{F}{d} = 24$ | $F = 24d$ | $d^2$ | $d$ | $\frac{1}{d}$ | **increases** | **stays the same** | **decreases**

Adapted with permission from UCLES, A Level, May 2009, OCR Physics A G481, Question 5

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# Moments 3i

A Level

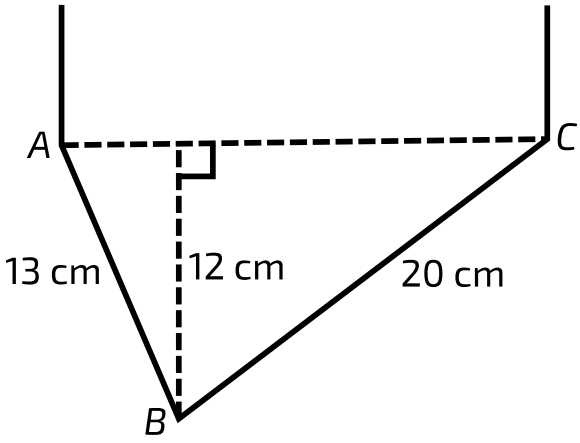


**Figure 1:** A rigid body consisting of two rods.

A rigid body $ABC$ consists of two uniform rods $AB$ and $BC$, rigidly joined at $B$. The lengths of $AB$ and $BC$ are $13\,\text{cm}$ and $20\,\text{cm}$ respectively, and their weights are $13\,\text{N}$ and $20\,\text{N}$ respectively. The distance of $B$ from $AC$ is $12\,\text{cm}$. The body hangs in equilibrium, with $AC$ horizontal, from two vertical strings attached at $A$ and $C$.

## Part A Tension in string at $A$

Find the tension in the string attached at $A$ correct to 3 significant figures.

## Part B Tension in string at $C$

Find the tension in the string attached at $C$ correct to 3 significant figures.

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Physics. You work it out.

Home Gameboard Maths Moments 2ii

# Moments 2ii

A Level

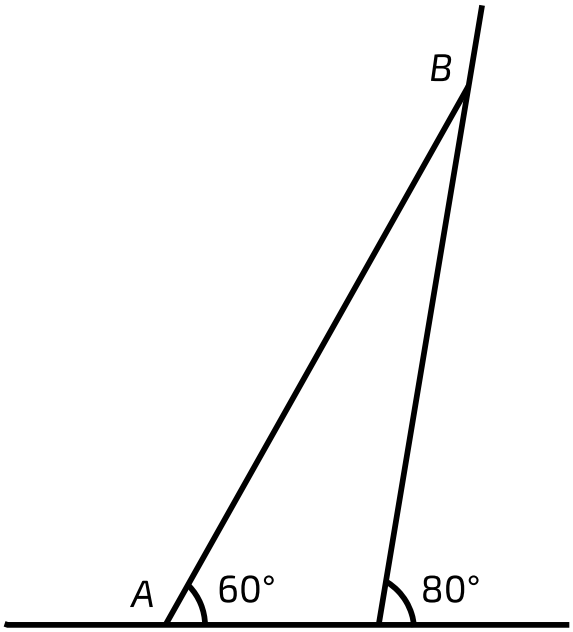


**Figure 1:** A uniform rod $AB$ resting in equilibrium in a vertical plane against a smooth wall.

A uniform rod $AB$, of weight $25\,\mathrm{N}$ and length $1.6\,\mathrm{m}$, rests in equilibrium in a vertical plane with the end $A$ in contact with rough horizontal ground and the end $B$ resting against a smooth wall which is inclined at $80^\circ$ to the horizontal. The rod is inclined at $60^\circ$ to the horizontal.

Calculate the magnitude of the force acting on the rod at $B$. Give your answer to 3 significant figures.



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# Moments 4i

A Level

A uniform square board of mass $10.0\,\mathrm{kg}$ and side $2.00\,\mathrm{m}$ is modelled as a lamina $ABCD$. The board is in equilibrium in a vertical plane with the point $A$ on rough horizontal ground. The edge $AD$ rests on a fixed wedge whose point of contact, $E$, is smooth. The distance $AE$ is $1.50\,\mathrm{m}$ and the edge $AD$ makes an angle of $15.0^\circ$ with the horizontal (see **Figure 1**).

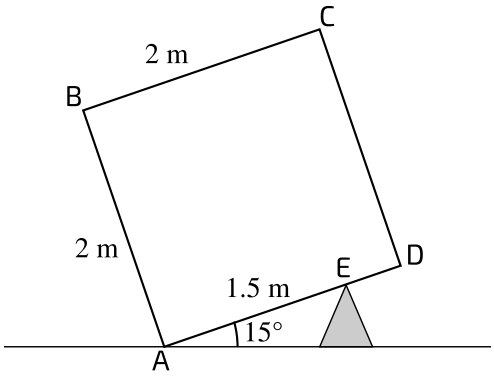


**Figure 1:** Board $ABCD$ resting in equilibrium on a smooth wedge.

## Part A Force at $E$

Calculate the magnitude of the force which the board exerts on the wedge at $E$.

## Part B Frictional force at $A$

Calculate the magnitude of the frictional force acting at $A$.

## Part C Value of $m$

A small object of mass $m\,\mathrm{kg}$ is now fixed to the board at $B$. Assuming that the board does not slip, calculate the maximum value of $m$ for which the board remains on the wedge.

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# Moments 2i

A Level

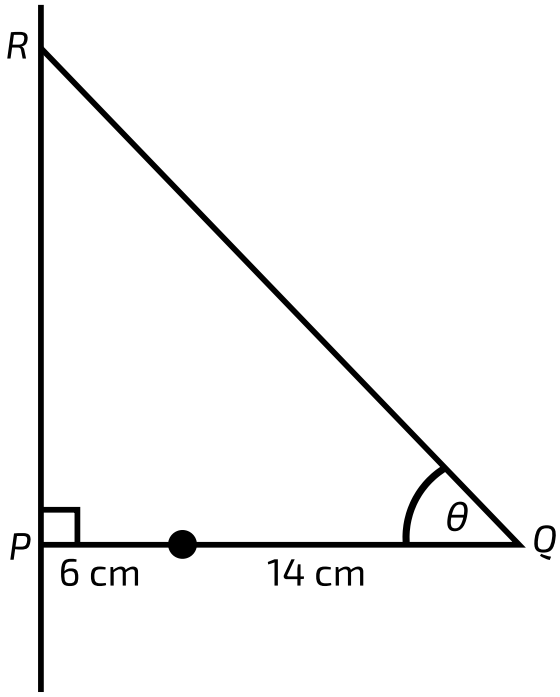


**Figure 1:** A uniform rod $PQ$ resting against a rough vertical wall at $P$ and held in a horizontal position, perpendicular to the wall, by a light inextensible string at $Q$.

A uniform rod $PQ$ has weight $18\,\mathrm{N}$ and length $20\,\mathrm{cm}$. The end $P$ rests against a rough vertical wall. A particle of weight $3\,\mathrm{N}$ is attached to the rod at a point $6\,\mathrm{cm}$ from $P$. The rod is held in a horizontal position, perpendicular to the wall, by a light inextensible string attached to the rod at $Q$ and to a point $R$ on the wall vertically above $P$, as shown in the diagram. The string is inclined at an angle $\theta$ to the horizontal, where $\sin\theta = \frac{3}{5}$. The system is in limiting equilibrium.

## Part A Tension in the string

Find the tension in the string to 3 significant figures.

## Part B Magnitude of the force

Find the magnitude of the force exerted by the wall on the rod to 3 significant figures.

## Part C Coefficient of friction

Find the coefficient of friction between the wall and the rod. Give your answer to 3 significant figures.

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# Moments 1ii

A Level

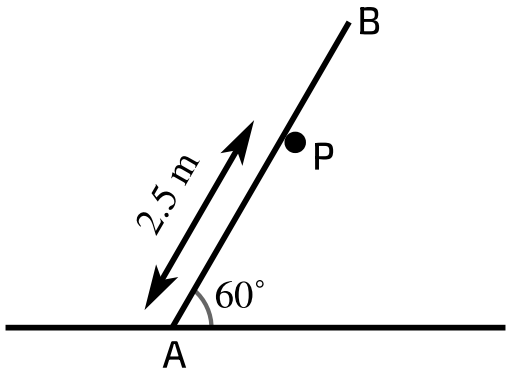


**Figure 1:** A uniform rod $AB$, in limiting equilibrium, is supported by a peg at $P$ and $A$ is on rough horizontal ground.

A uniform rod $AB$, of mass $3\,\text{kg}$ and length $4\,\text{m}$, is in limiting equilibrium with $A$ on rough horizontal ground. The rod is at an angle of $60^\circ$ to the horizontal and is supported by a small smooth peg $P$, such that the distance $AP$ is $2.5\,\text{m}$ (see **Figure 1**).

## Part A Force on the rod

Find the force acting on the rod at $P$. Give your answer to 2 significant figures.

## Part B Coefficient of friction

Find the coefficient of friction between the ground and the rod. Give your answer to 2 significant figures.