Moments 3ii

A Level

P P P

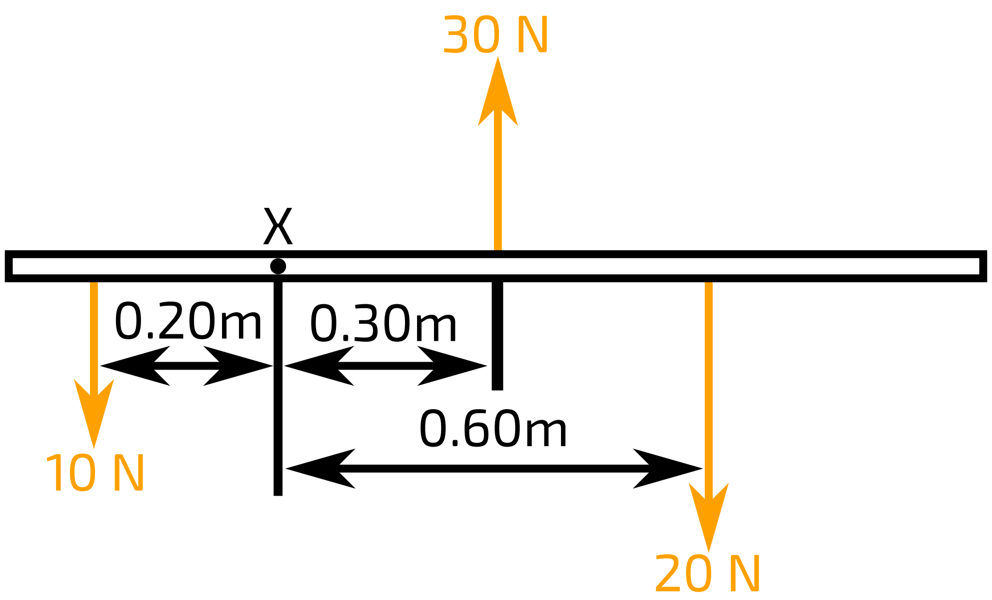

Figure 1: Three forces acting on a rod.

Figure 1 shows three forces acting on a rod.

Part A Moments about 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, in which direction will it rotate?

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

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.

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Physics. You work it out.

Moments 4ii

A Level
P P P

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.

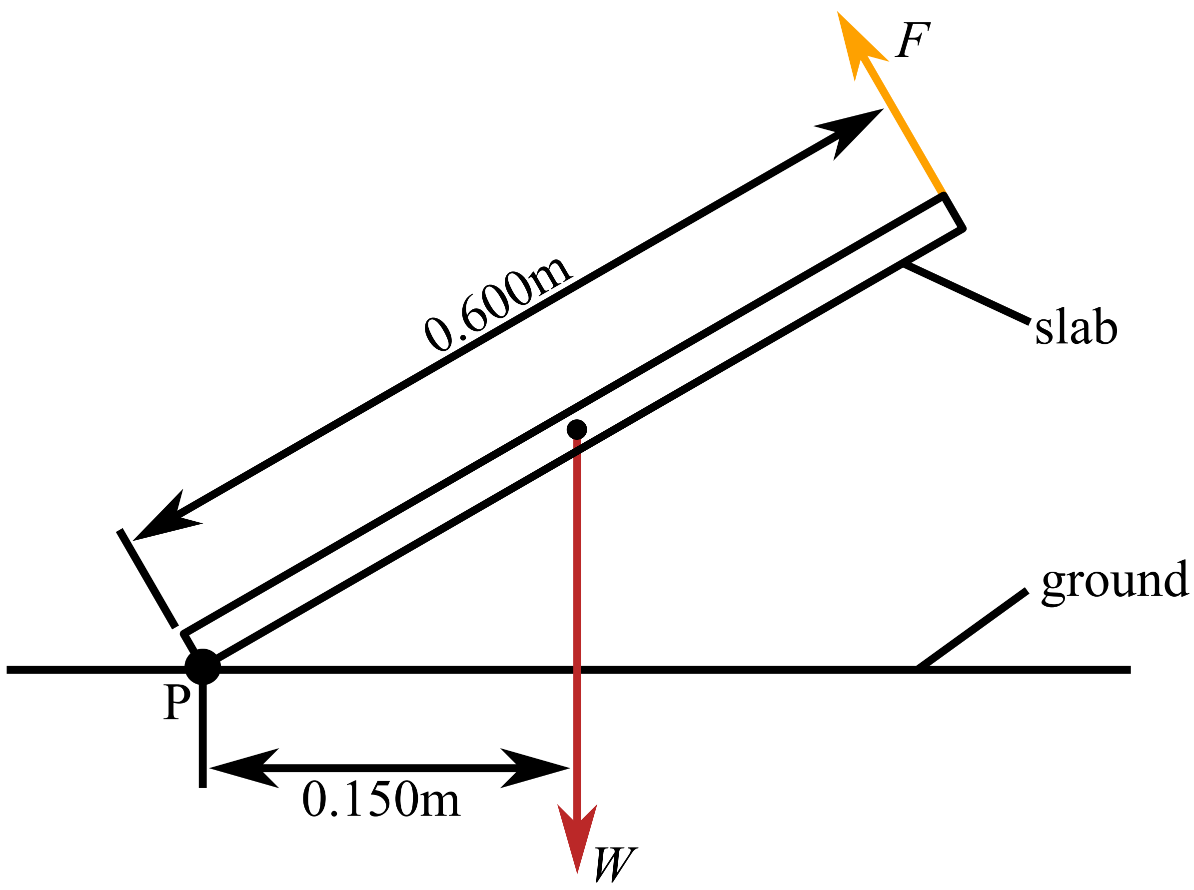

Figure 1: A concrete paving slab in equilibrium.

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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Home Gameboard Maths Moments 5i

Moments 5i

A Level
P P P

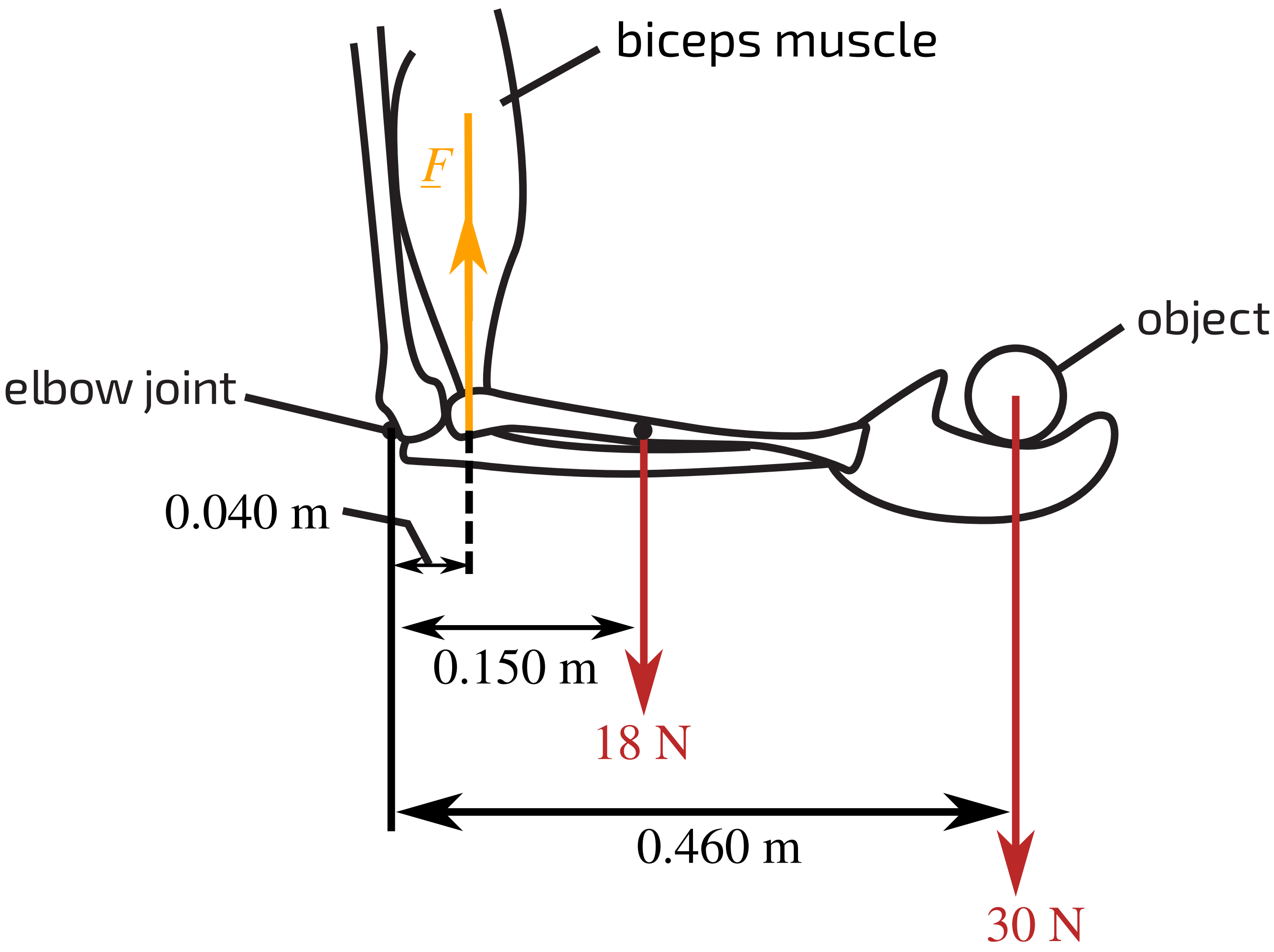

Figure 1: A human arm lifting an object.

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

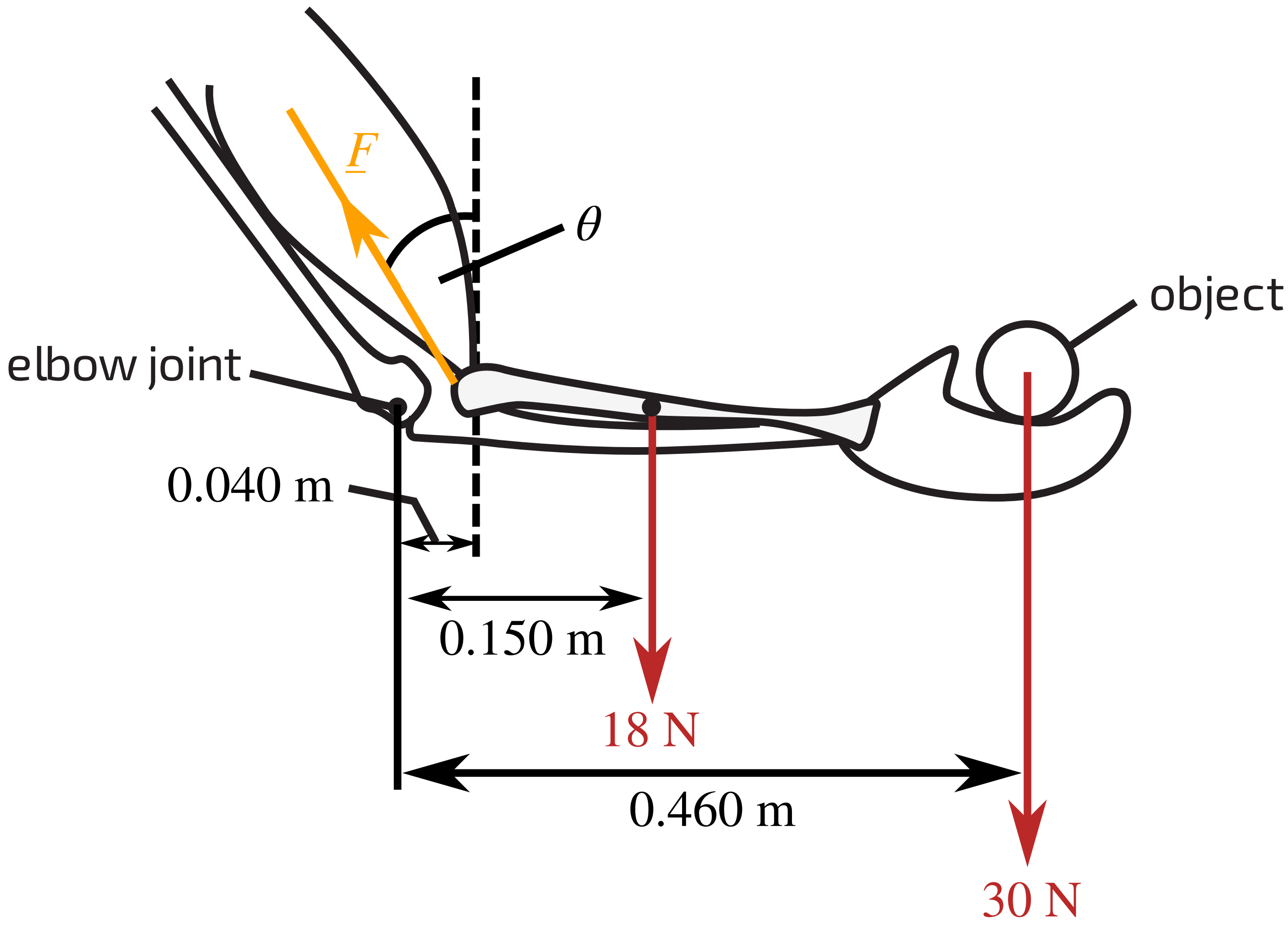

Figure 2: An arm holding a ball with the lower arm moved away from the body.

As the lower arm is moved away from the body, the force F exerted by the biceps muscles acts at an angle θ 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 θ is increased:

As θ increases, what happens to the anticlockwise moment about the elbow joint?

- It stays the same
- It decreases
- It increases

As θ increases, what happens to the magnitude of the force F?

- It stays the same
- It decreases
- It increases

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Moments 5ii

A Level P P P

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

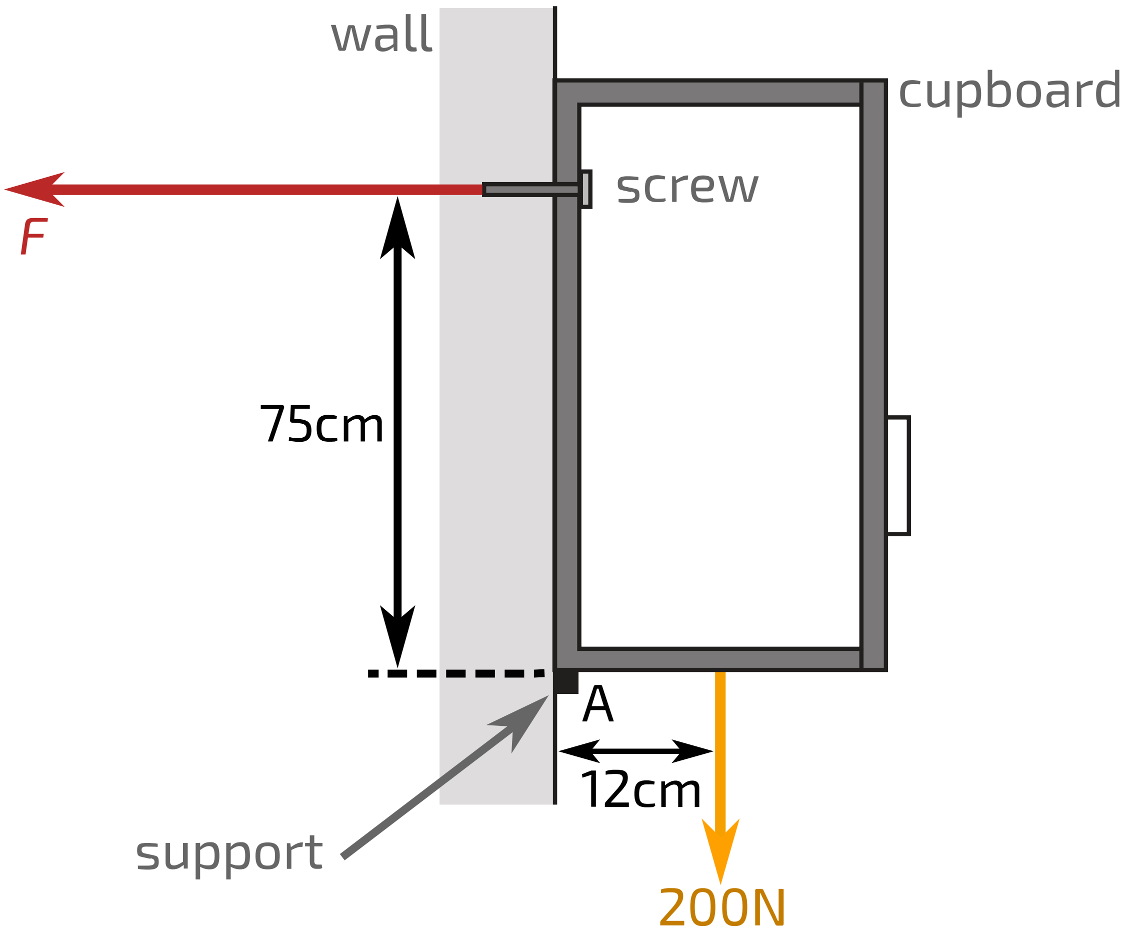

Figure 1: The forces acting on a cupboard.

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 d represent the distance from the line of action of F to the support at A. 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**

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Moments 3i

A Level
P P P

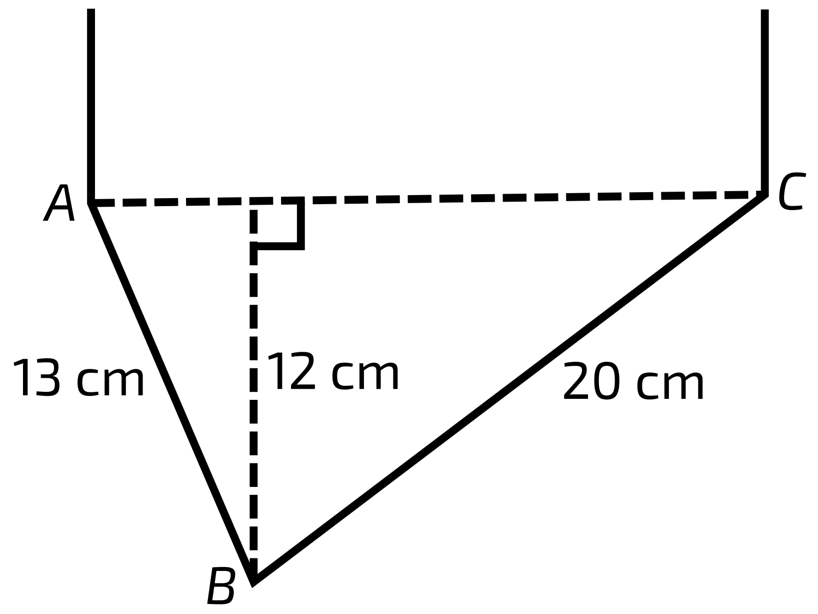

Figure 1: A rigid body consisting of two rods.

A rigid body ABC consists of two uniform rods AB and BC, rigidly joined at B. The lengths of AB and BC are $13\,\mathrm{cm}$ and $20\,\mathrm{cm}$ respectively, and their weights are $13\,\mathrm{N}$ and $20\,\mathrm{N}$ respectively. The distance of B from AC is $12\,\mathrm{cm}$. 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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Moments 2ii

A Level
P P P

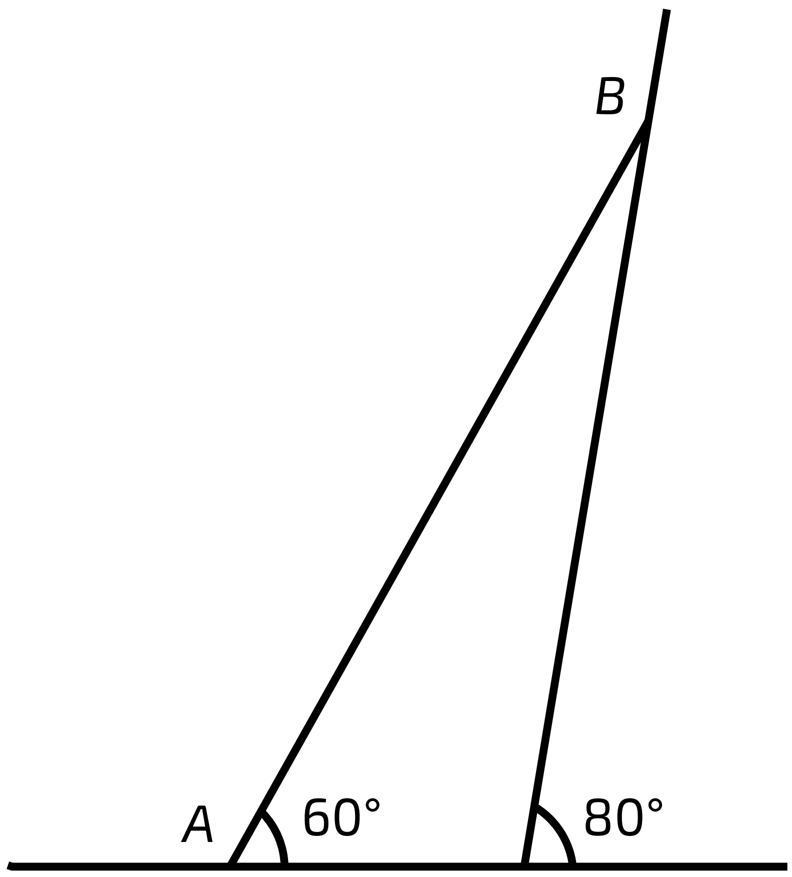

Figure 1: A uniform rod AB resting in equilibrium in a vertical plane against a smooth wall.

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

P P P

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° with the horizontal (see **Figure 1**).

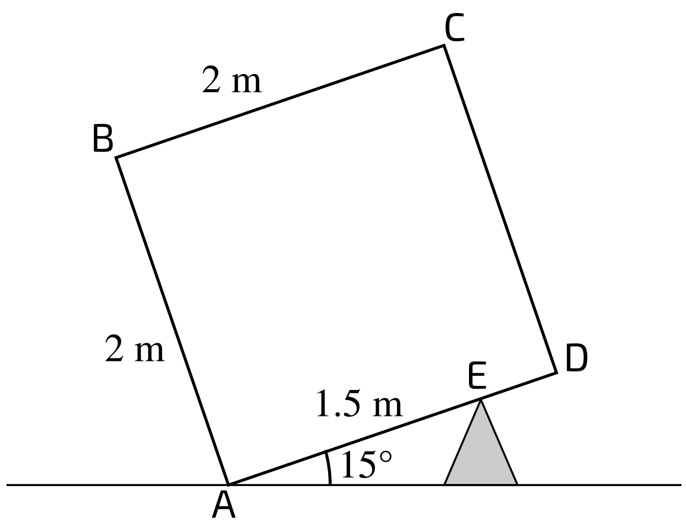

Figure 1: Board $ABCD$ resting in equilibrium on a smooth wedge.

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
P P P

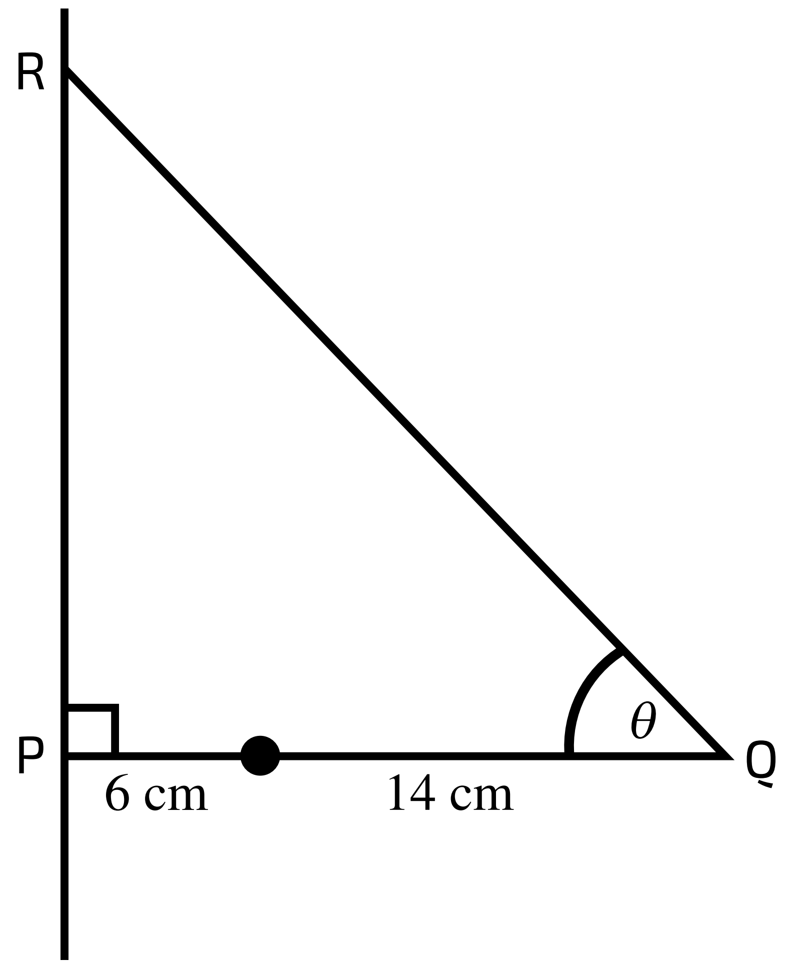

Figure 1: A uniform rod PQ resting against a rough vertical wall at P and held in a horizontal position, perpendicular to the wall, by a light inextensible string at Q.

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 θ 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

P P P

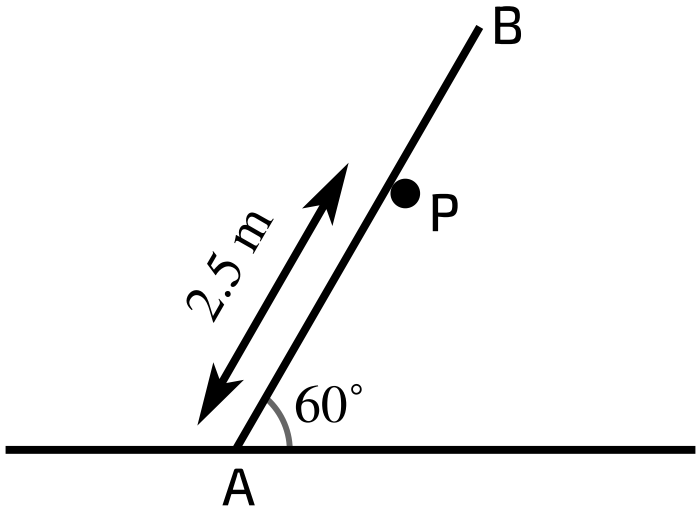

Figure 1: A uniform rod AB, in limiting equilibrium, is supported by a peg at P and A is on rough horizontal ground.

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

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