M1 Moments: exam questions

10 questions · 36 marks · full mark schemes

Name _____ Date _____ Score / 36

- Moment of a force; equilibrium of a rod under parallel coplanar forces, including non-uniform rods and rods on the point of tilting.
- Try every question before you look at the mark schemes. They start after the questions: M marks for method, A marks for accuracy, B marks for a correct result on its own.
- Online, with more practice: alevelmathrevision.com/alevel-frontend/units/m1/moments-questions

1. **2 marks · warm-up**

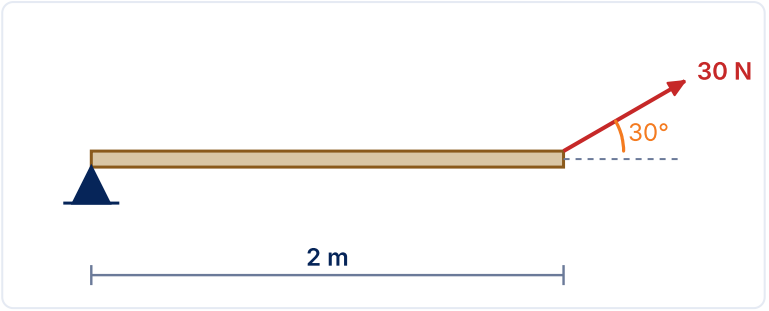
State the two conditions for a rigid body in equilibrium.

2. **2 marks · warm-up**

A force of $15\ \text{N}$ is applied to a spanner at a perpendicular distance of $0.4\ \text{m}$ from the nut. Calculate the moment of the force about the nut.

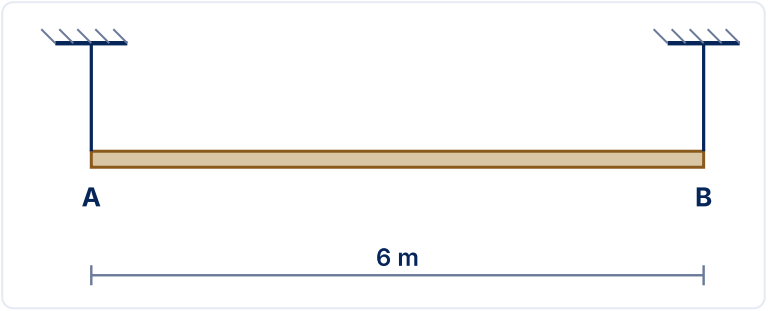
3. 3 marks · standard

A force of $30\ \text{N}$ acts at an angle of $30°$ to a lever of length $2\ \text{m}$. Calculate the moment of the force about the pivot at the other end.



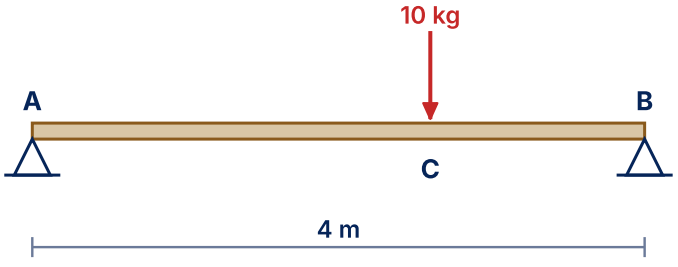
4. 3 marks · standard

A uniform beam AB of length $6\ \text{m}$ and mass $12\ \text{kg}$ is supported horizontally by two vertical strings attached at A and B. Find the tension in the string at A.



5. 4 marks · standard

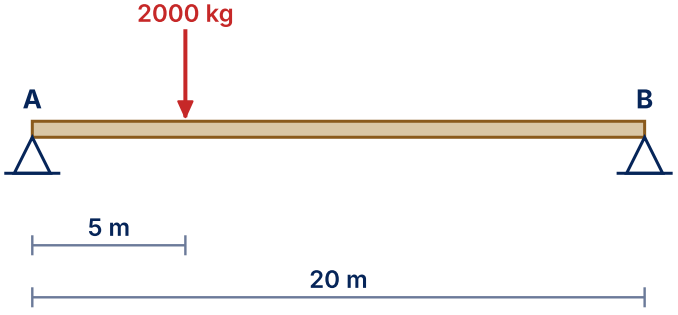
A uniform plank of length $4\ \text{m}$ and mass $15\ \text{kg}$ rests horizontally on supports at A and B. A mass of $10\ \text{kg}$ is placed at a point C on the plank. The reaction at A is $15g\ \text{N}$ and the reaction at B is $10g\ \text{N}$. Find the distance AC.



C drawn at a general point

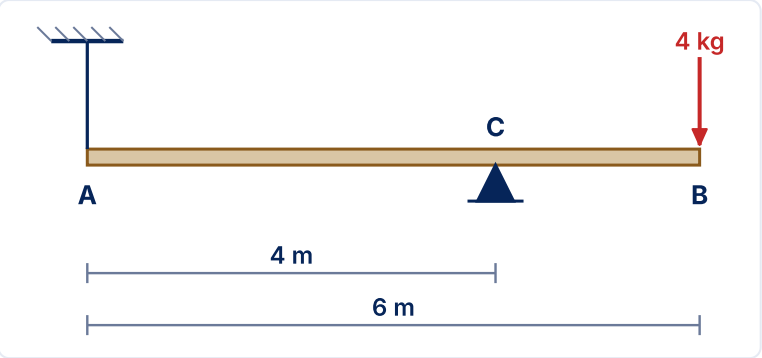
6. 4 marks · standard

A uniform bridge of length $20\ \text{m}$ and mass $5000\ \text{kg}$ is supported by two pillars at its ends, A and B. A stationary truck of mass $2000\ \text{kg}$ is $5\ \text{m}$ from A. Calculate the reaction at pillar B.



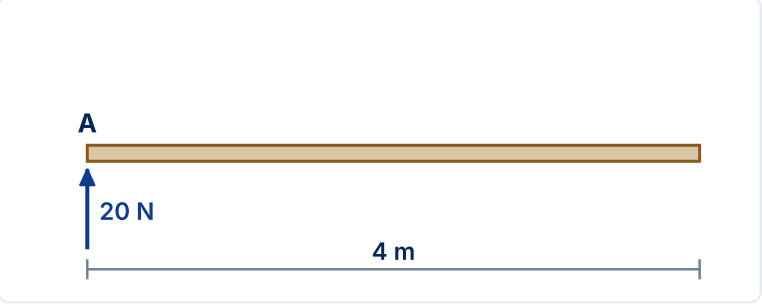
7. 4 marks · harder

A uniform beam AB of length $6\ \text{m}$ and mass $12\ \text{kg}$ is held horizontally. It is supported by a vertical string at A and a pivot at C, which is $4\ \text{m}$ from A. A mass of $4\ \text{kg}$ rests at B. Find the tension in the string at A.



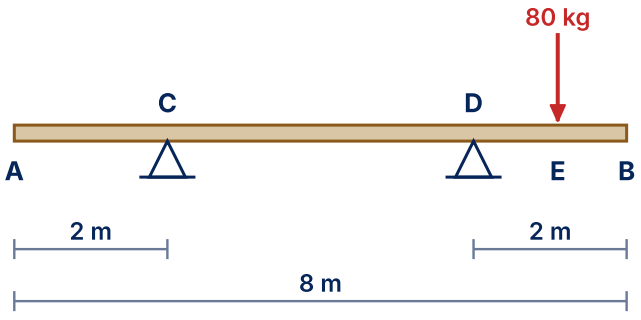
8. 4 marks · harder

A uniform rod of mass $6\ \text{kg}$ and length $4\ \text{m}$ is held horizontally. An upward force of $20\ \text{N}$ is applied at end A. A single support is placed under the rod to keep it in equilibrium. Find the distance of this support from A.



9. 5 marks · harder

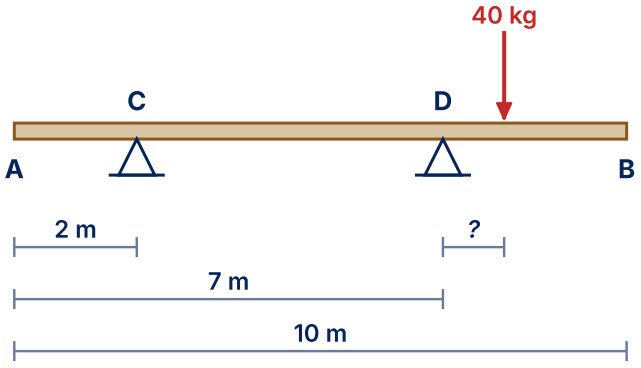
A uniform plank AB of length $8\ \text{m}$ and mass $20\ \text{kg}$ rests horizontally on two supports at C and D, where $AC = 2\ \text{m}$ and $DB = 2\ \text{m}$. A man of mass $80\ \text{kg}$ stands on the plank at the point E, between D and B. The plank is on the point of tilting about D. Modelling the man as a particle, find (a) the distance DE, (b) the reaction at D.



E drawn at a general point between D and B

10. 5 marks · harder

A uniform beam AB of length $10\ \text{m}$ and mass $30\ \text{kg}$ rests horizontally on supports at C and D, where $AC = 2\ \text{m}$ and $AD = 7\ \text{m}$. A child of mass $40\ \text{kg}$ walks along the beam from C towards B. Find the maximum distance the child can walk past D before the beam tilts.



child drawn at a general point past D

Answers and worked solutions

Question 1 — 2 marks

Answer: $\sum F = 0$ and $\sum M = 0$.

$\sum F = 0$ (no net force) **B1**. $\sum M = 0$ about any point (no net moment) **B1**.

Question 2 — 2 marks

1. M1 for using the formula $\text{Moment} = \text{Force} \times \text{perpendicular distance}$.
2. A1 for calculating $15 \times 0.4 = 6\ \text{N m}$.

Question 3 — 3 marks

1. M1 for identifying the perpendicular component of the force or the perpendicular distance: $F\sin\theta \times d$ or $F \times d\sin\theta$.
2. M1 for substituting the values: $30 \times 2 \times \sin 30°$.
3. A1 for evaluating to $30\ \text{N m}$.

Question 4 — 3 marks

1. M1 for taking moments about B (or A) to eliminate one tension: $T_A \times 6 = 12g \times 3$.
2. M1 for rearranging to solve for T_A: $6T_A = 36g$.
3. A1 for calculating $T_A = 6g = 58.8\ \text{N}$.

Question 5 — 4 marks

1. M1 for taking moments about A: $10g \times 4 = 15g \times 2 + 10g \times x$, where $x = AC$.
2. M1 for evaluating the moments: $40g = 30g + 10gx$.
3. M1 for cancelling g and isolating x: $10x = 10$.
4. A1 for calculating $x = 1\ \text{m}$.

Question 6 — 4 marks

1. M1 for taking moments about A: $R_B \times 20 = 5000g \times 10 + 2000g \times 5$.
2. M1 for evaluating the moments: $20R_B = 50000g + 10000g = 60000g$.
3. M1 for solving for R_B: $R_B = 3000g$.
4. A1 for calculating $R_B = 29400\ \text{N}$.

Question 7 — 4 marks

1. M1 for taking moments about the pivot C: $T_A \times 4 + 4g \times 2 = 12g \times 1$.
2. M1 for calculating the individual moments correctly.
3. M1 for rearranging to solve for T_A: $4T_A = 12g - 8g = 4g$.
4. A1 for finding $T_A = g = 9.8\ \text{N}$.

Question 8 — 4 marks

1. M1 for resolving vertically to find the reaction R at the support: $R + 20 = 6g$.
2. M1 for calculating $R = 58.8 - 20 = 38.8\ \text{N}$.
3. M1 for taking moments about A: $R \times x = 6g \times 2 \implies 38.8 \times x = 117.6$.
4. A1 for solving $x = 3.03\ \text{m}$ (to 3 s.f.).

Question 9 — 5 marks

Answer: (a) $DE = 0.5\ \text{m}$; (b) $R_D = 100g = 980\ \text{N}$

1. B1 for $R_C = 0$ when the plank is on the point of tilting about D.
2. M1 for taking moments about D: $80g \times DE = 20g \times 2$ (the weight of the plank acts $2\ \text{m}$ from D on the other side).
3. A1 for $DE = 0.5\ \text{m}$.
4. M1 for resolving vertically: $R_D = 20g + 80g$.
5. A1 for $R_D = 100g = 980\ \text{N}$.

Question 10 — 5 marks

1. M1 for identifying that tilting occurs about D, meaning the reaction at C becomes zero.
2. M1 for taking moments about D: the child's clockwise moment equals the beam's anticlockwise moment.
3. M1 for setting up the equation: $30g \times (7 - 5) = 40g \times x$, where x is the distance past D.
4. M1 for simplifying: $60g = 40gx$.
5. A1 for solving to find $x = 1.5\ \text{m}$.

More moments practice with instant feedback: alevelmathrevision.com/alevel-frontend/units/m1/moments-questions
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