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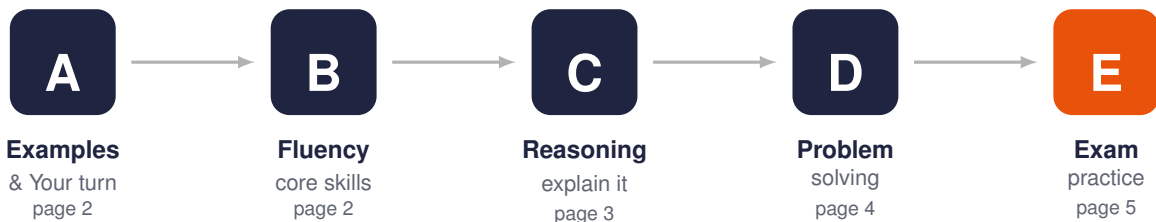
A-LEVEL MATHEMATICS • MECHANICS 1

Moments

Worked Solutions

Pearson Edexcel International A Level (WME01) & A Level (9MA0) • Calculator and statistical tables allowed: take $g = 9.8 \text{ m s}^{-2}$ and give answers to 2 or 3 s.f.

Full worked solutions for the free Moments worksheet, A-Level and International A-Level Maths



Tap a section to jump straight to it

Full worked solutions for every question on the Mechanics 1 Moments worksheet, in the same order and with the same question numbers.

How to mark your work. Tick each step you got right, not just the final answer. At A-level most marks are for method, so a wrong final answer can still earn most of the marks. If you lost marks, find the *first* line where your working is different from ours. That is the thing to fix.

In Section E: **M** = method mark, **dm** = method mark that depends on the previous M mark, **A** = accuracy mark (needs the M mark before it), **B** = independent mark.

Question sheet

Exam questions by topic

Mechanics 1 exam questions

More worksheets



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A**Your turn answers**

Compare each line of your working with the solution.

CORE

A1 40×0.35 : **14 N m**

A2 $20 - 15$: **5 N m clockwise**

A3 $6R_B = 60(3) + 40(2)$: **$R_B = 43.3 \text{ N}$, $R_A = 56.7 \text{ N}$**

STRETCH

A4 $80(1) = W(1.5)$: **53.3 N**

A5 $R_B = 15$; $15(3) = 40x$: **1.125 m from A**

A6 $\frac{0 + 2 + 4.5}{8}$: **0.8125 m**

A7 $4.5T_D = 90(3)$: **$T_D = 60 \text{ N}$, $T_A = 30 \text{ N}$**

B**Fluency solutions**

One mark for each correct part. The notes in italics explain why each sequence was chosen.

CORE

B1 (a) $5R_B = 400(2.5) + 600x$: **$200 + 120x$** (b) **$800 - 120x$** (c) **$x = 2.5$** (d) $R_B = \frac{1000}{3}$: **$x = 1.11$**

The two reactions always add to 1000 N

B2 (a) $4T_B = 300(2) + 700(1)$: **325 N** (b) **675 N** (c) **the middle, 2 m from A** (d) $4T_A = 300(2)$: **150 N**

Equal tensions need the load at the beam's own centre of mass.

B3 (a) $4F_B = 150(1.6)$: **60 N** (b) **90 N** (c) $3F = 240$: **80 N** (d) **70 N**

Moving inwards puts more of the load on that person.



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B4 (a) $R_A = 0$: $240(1) = 360d$: **0.667 m** (b) **4.67 m** (c) **600 N** (d) $240 = 480d$: **0.5 m**

At the point of tilting, all the weight is on C

CORE

B5 (a) $\frac{1(1.2) + 3(2)}{8}$: **0.9 m** (b) **0.9 m from A** (c) $8g$: **78.4 N**

A single support balances the rod only under its centre of mass.

B6 (a) **30 N** (b) $30(3) = 90x$: **1 m** (c) $3R_B = 90(1) + 30(3)$: **60 N** (d) **60 N**

The supports share the extra 30 N unequally.

STRETCH

B7 (a) $6(0.05) = 4d$: **0.075 m** (b) $5(0.35) + 0.3 = 4d$: **0.5125 m** (c) $0.35L + 0.3 = 4(0.65)$: **6.57 N**
(d) **15 N**

The rod's own weight acts on the load side of the pivot.

B8 (a) $900(0.2) = 1.3F$: **138 N** (b) **1040 N** (c) $\frac{135}{1.35}$: **100 N** (d) $1.3F + 20(0.55) = 180$: **130 N**

A pivot close to the load gives a large advantage.

B9 (a) **200 N** (b) $80(4) = 200x$: **1.6 m** (c) $4T_B = 200(1.6) + 100(4)$: **180 N** (d) **120 N**

A load at B is carried entirely by the rope at B

B10 (a) $3R_D = 500$: **$R_C = 333 \text{ N}$, $R_D = 167 \text{ N}$** (b) $4(166.7) = 300(2) + 200(x - 1)$: **1.33**

(c) $4(250) = 600 + 200(x - 1)$: **3** (d) $4R_D = 600 - 200$: **100 N**

Write both reactions in one unknown before taking moments.

C

Reasoning solutions

Your wording can be different. Check that your reason makes the same point.

CORE

C1 The distance is from C, not A: $1.5 - 0.5 = 1 \text{ m}$: **40 N m**



C2 50 N is already a weight: **the moment is $50 \times 1.2 = 60 \text{ N m}$** , with no g

C3 About to tilt about D , the beam lifts off C : **$R_C = 0$** , not R_D

C4 Its weight does not act at the midpoint: **the centre of mass is an unknown distance x from one end**.

STRETCH

C5 Adding a load changes both tensions, so **T_A must be found again** from new equations.

C6 A rod can have weight; the model means **it is rigid and stays straight**.

C7 The tensions depend on the distances to the centre of mass; **they are equal only if the ropes are equally far from it**.

C8 (a) Moments about A : $lR_B = W \cdot \frac{l}{2} + Lx$, so **$R_B = \frac{W}{2} + \frac{Lx}{l}$** ; resolve: **$R_A = \frac{W}{2} + L - \frac{Lx}{l}$**

(b) **R_B increases linearly, by $\frac{L}{l}$ for each metre**, from $\frac{W}{2}$ to $\frac{W}{2} + L$

D

Problem solving solutions

There is often more than one correct method. Any complete, correct method scores full marks.

CORE

D1 Moments about A : $25AD = 40(2.5)$: **$AD = 4 \text{ m}$** ; $40 - 25$: **$T_A = 15 \text{ N}$**

D2 (a) Moments about A : $4R_B = 200(1.5) + 600x$: **$75 + 150x$**

(b) $R_A + R_B = 800$ and $R_A = 3R_B$, so $R_B = 200$: **$x = 0.833$**

D3 $T_C + T_D = 450$, $T_D = 2T_C$: $T_C = 150$, $T_D = 300$. Moments about C : $300(4) = 300(2) + 150(x - 1)$: **$x = 5$**

D4 Moments about C : $2.5R_D = 100(1.5) + 60(3.5)$: **$R_D = 144 \text{ N}$** ; $160 - 144$: **$R_C = 16 \text{ N}$**



STRETCH

- D5** (a) It balances on a string there with nothing attached: **0.8 m**
 (b) Moments about M : $3(1) = W(1 - 0.8)$: **$W = 15$**
- D6** Each reaction = $\frac{1250}{2} = 625$. Moments about C : $625(1.7) + 600(0.5) = 150(1) + 500(y - 0.5)$: **2.925 m**
- D7** (a) Moments about A : $1.5F = 400(0.5) + 150(0.7)$: **203 N**
 (b) $550 - 203.3$: **347 N** (c) $\frac{120 + 105}{1.5}$: **150 N**
- D8** (a) $R_C = 100$, $R_D = 200$. Moments about A : $100(1) + 200(4.5) = 300x$: **3.33 m**
 (b) Moments about C : $3.5R_D + 400(1) = 300(2.333)$: **85.7 N**

E

Exam practice solutions

Mark-scheme notes are shown on the right of each line.

CORE

Exam questions for everyone

- E1** (a) Moments about A : $3T_C = 20g(2)$ M1 A1
 $T_C = 131 \text{ N}, T_A = 65.3 \text{ N}$ A1
 (b) $3T_C = 20g(2) + 15g(4)$ M1
 327 N A1
 (c) Turning about C : $T_A = 0$; $20g(1) = Mg(1)$ M1
 $M = 20$ A1
- E2** (a) Moments about C : $10(0.05) = 4d$ M1
 0.125 A1
 (b) $0.1L + 10(0.05) = 4d$ M1
 $d = 0.025L + 0.125$ A1*
 (c) $d \leq CB = 0.7$: $0.025L + 0.125 = 0.7$ M1
 23 N A1
 (d) $23 + 10 + 4$ M1
 37 N A1



STRETCH

- E3** (a) Moments about D (4 m from A): $3T_C = 40g(1) + 80g(4 - x)$ $M1 A1$
- $T_C = \frac{1}{3}(360 - 80x)g$ $A1^*$
- (b) $120g - T_C$: $T_D = \frac{80xg}{3}$ $B1$
- (c) Not slack: $0 \leq x \leq 4.5$. Not breaking: $\frac{1}{3}(360 - 80x)g \leq 900, x \geq 1.06$ $M1 A1$
- $\frac{80xg}{3} \leq 900, x \leq 3.44$: $1.06 \leq x \leq 3.44$ $M1 A1$
- (d) **Its weight acts at the midpoint**; e.g. **the cables are light and vertical** $B1 B1$

