

Name	Date started	Target end date
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GCE A LEVEL – APPLIED MATHEMATICS B QUESTION PACK

0980-01 (Legacy M1) · New spec Unit 4 Topic 8 · A2 unit, 15% of A-level, 80 marks, 1h 45min paper

REVISE

.wales

MATHEMATICS – APPLIED B · MOMENTS & RIGID BODY EQUILIBRIUM

Moments and Rigid Body Equilibrium

Every moments / rigid-body equilibrium question from the legacy WJEC M1 papers (2011–2017). Rods and planks on supports, on-point-of-tilting analysis, non-uniform rods and rigid frames

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~2 hours 2 minutes

Derived from the legacy M1 paper's pace of ~1.25 min/mark (98 marks over 11 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains questions from the legacy WJEC M1 papers (2008 modular spec) that maps onto new-spec A2 Unit 4 Topic 8 (2.4.7).

Questions are ordered chronologically.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working – method marks are awarded for clear setup.

A calculator is allowed (except where specified by individual questions). The WJEC Formula Booklet and statistical tables may be referred to. Take $g = 9.8 \text{ ms}^{-2}$ for mechanics.

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Q	Source	Max	Mark
1	Jun 11 Q4	6	
2	Jun 11 Q8	11	
3	Jan 12 Q7	8	
4	Jun 12 Q8	6	
5	Jan 13 Q7	10	
6	Jun 13 Q5	10	
7	Jan 14 Q7	11	
8	Jun 14 Q4	7	
9	Jun 15 Q5	12	
10	Jun 16 Q6	7	
11	Jun 17 Q3	10	
Total		98	

Moments and Rigid Body Equilibrium – what the new spec asks

WJEC GCE A Level Mathematics (from 2017) · Unit 4: Applied Mathematics B · Topic 2.4.7.

Moments and equilibrium 2.4.7

- Moment of a force about a point = force \times perpendicular distance.
- Rigid body in equilibrium: sum of forces = 0 and sum of moments about any point = 0.
- Choose pivot to eliminate unknown forces from the moment equation.

Rods, planks and on-point-of-tilting 2.4.7

- For a uniform rod / plank, weight acts at the midpoint.
- Non-uniform rod: centre of mass position is an unknown (use moments to find it).
- About to tilt about a support: reaction at the other support = 0.

Moments & Rigid Body Equilibrium in one page

Quick-reference notes – revisit before each section. Don't use during questions.

Moment of a force

Moment about a point = $F \times d_{\perp}$ where d_{\perp} is the perpendicular distance.

Units: N·m. Sign convention: anticlockwise positive (or pick one consistently).

Equilibrium conditions

$\sum F = 0$ (resolve in two perpendicular directions).

$\sum M = 0$ about any point.

Choose the pivot point to eliminate the largest unknown force from the moments equation.

Uniform rod / plank

Weight $W = Mg$ acts at the midpoint of a uniform rod.

Length L , mass at $L/2$ from either end.

Non-uniform rod

Centre of mass at unknown distance \bar{x} from one end.

Use two moment equations (or moments + a force resolution) to find both \bar{x} and unknown reactions.

On the point of tilting

About to tilt about a support S : reaction at the *other* support is 0.

Take moments about S to find the limiting load / position.

Frame of light rods

Light rod \Rightarrow no weight; tension or thrust acts along the rod.

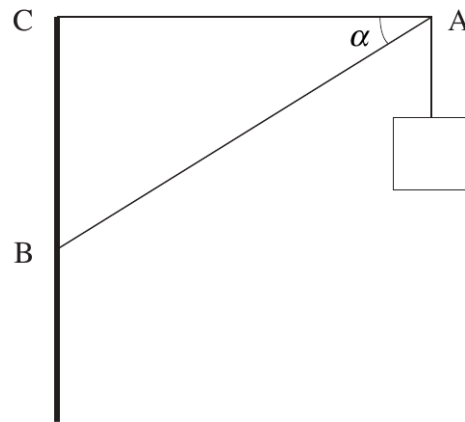
At a joint where rods meet: resolve in two directions and balance with external force (weight of attached object).

SECTION T8

Moments and Rigid Body Equilibrium

Questions 1-11 · 98 marks

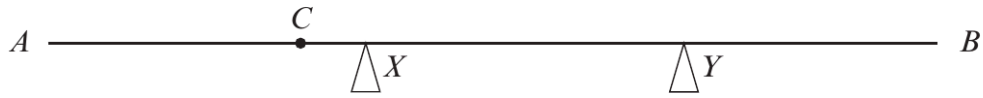
4. The diagram shows a sign attached to a point A . It is supported by two light rods AB and AC . The rod AC is horizontal and the rod AB is inclined at an angle of α to the horizontal, where $\sin \alpha = 0.6$.



The mass of the sign is 12 kg. Calculate

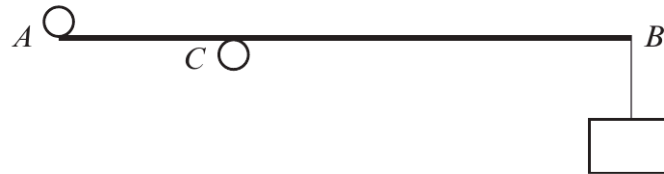
- (a) the thrust in the rod AB , [3]
- (b) the tension in the rod AC . [3]

8. The diagram shows a uniform rod AB , of mass 4 kg and length 1.6 m , with a particle, of mass 0.5 kg , attached at a point C of the rod, where $AC = 0.5\text{ m}$. The rod is resting horizontally in equilibrium on two smooth supports at points X and Y of the rod, where $AX = 0.6\text{ m}$ and $AY = 1.2\text{ m}$.



- (a) Calculate the reaction at X and the reaction at Y . [7]
- (b) When an additional particle of mass $M\text{ kg}$ is attached to the point C , the rod is on the point of turning about X . Calculate the value of M . [4]

7. The diagram shows a body, of mass 65 kg, attached to the end B of a uniform rigid rod AB of length 4 m. The mass of the rod is 35 kg. The rod is held horizontally in equilibrium by two smooth cylindrical pegs, one at A and another at C , where $AC = 1.2$ m.



- (a) Write down the moment of the weight of the rod about the point A .
State your units clearly. [2]
- (b) Find the forces exerted on the rod at A and C . [6]

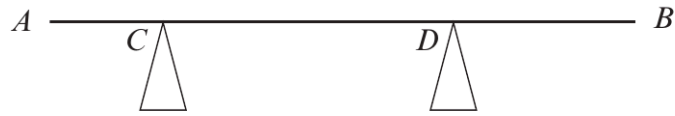
8. A light uniform rod AB has length 1.4 m . A particle of mass 5 kg is attached to end A , and a particle of mass 2 kg is attached to end B . The rod rests horizontally in equilibrium on a smooth support at C .

(a) Calculate the reaction of the support at C . [2]

(b) Find the distance AC . [4]

TURN OVER

7. A uniform beam AB , of length 6 m, rests in a horizontal position on two smooth supports at C and D , where $AC = 1$ m and $BD = 1.2$ m, as shown in the diagram.



- (a) When a vertical force of magnitude 1800 N is applied upwards to the beam at the end A , the beam is about to tilt about the support at D . Determine the weight of the beam. [5]
- (b) The vertical force is now removed so that the beam is resting in equilibrium on the two supports. Calculate the magnitude of the reaction of each of the supports at C and D on the beam. [5]

5. The diagram shows a uniform plank AB of mass 12 kg and length 2 m . The plank rests horizontally in equilibrium on two supports at C and at D , where $AC = 0.8\text{ m}$ and $AD = x\text{ m}$.



- (a) The reaction of the support on the plank at D has magnitude 84 N .
- (i) Determine the reaction of the support on the plank at C . [7]
- (ii) Calculate the value of x . [7]
- (b) A rock of mass $M\text{ kg}$ is placed at A so that the plank is on the point of tilting about C . Calculate the value of M . [3]

7. A uniform plank AB , of length 4.8 m and mass M kg, is resting on two smooth supports at points X and Y , such that $AX = BY = 1.2$ m.
- (a) A person of mass 84 kg stands on the plank at a point which is 0.8 m from B . The reaction of the support at X is of magnitude 156.8 N.
Find
- the value of M ,
 - the magnitude of the reaction of the support at Y . [6]
- (b) The person of mass 84 kg walks along the plank towards A . At the instant that the plank starts to tilt about X , find
- the magnitude of the reaction of the support at X ,
 - the distance of the person from X . [5]

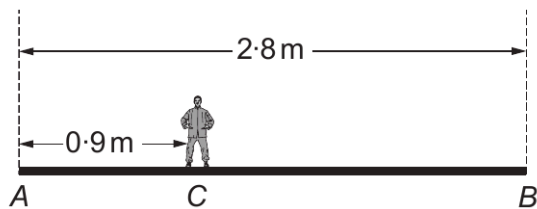
4. The diagram shows a uniform rod AB , of length 1.8 m and mass 3 kg , held in horizontal equilibrium by two small fixed cylinders C and D . An object of mass 12 kg rests on the rod at B . The length AC is 0.3 m and CD , the distance between the cylinders, is 0.4 m . The force exerted on the rod by each of the cylinders is vertical.



Find the magnitude of each of the forces exerted on the rod by the cylinders.

[7]

5. The diagram shows a plank AB , of mass 15 kg and length 2.8 m , being held in equilibrium with AB horizontal by means of two vertical ropes, one attached to the end A and the other attached to the end B . A man of mass 80 kg stands on the plank at point C , where $AC = 0.9\text{ m}$.



- (a) Modelling the plank as a uniform rod, find the tensions in the ropes attached to the end A and the end B of the plank. [7]
- (b) The plank is now modelled as a **non-uniform** rod. Given that the tension in the rope attached to A is 1.5 times the tension in the rope attached to B , determine the distance of the centre of mass of the plank from A . [5]

6. A uniform rod AB is of mass 8 kg and length 6 m . It is suspended horizontally in equilibrium by means of two vertical light strings attached to the rod AB at point C and point D on the rod, where $AC = 1.6\text{ m}$ and $AD = 4.8\text{ m}$. Calculate the tension in the string at C and the tension in the string at D . [7]

3.



The diagram shows a uniform plank AB , of mass 20 kg and length 2.4 m , supported in horizontal equilibrium by two pivots, one at C and one at D . The distance AC and the distance DB are both 0.5 m . A person of mass 40 kg stands at a point which is 0.6 m from B .

- (a) Calculate the magnitudes of the reaction at C and the reaction at D . [7]
- (b) The person starts to walk towards A . Determine the greatest distance of the person from B if equilibrium is to be maintained. [3]

END OF MOMENTS & RIGID BODY EQUILIBRIUM PACK

Source: WJEC M1 (2008 modular spec) · 2011–2017
Curated for WJEC Maths 2017 spec A2 Unit 4 – Topic 8 (2.4.7)

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