3.3 Mechanics: Moments: 30-minute Pack

EDEXCEL 9MA0 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A force of 15 N acts at right angles to a bar at a point 3 m from a pivot. Find the moment of the force about the pivot.

(Total for Question 1 is 1 mark)

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2 State the condition that must be satisfied by the moments of the forces acting on a rigid body for the body to be in rotational equilibrium.

(Total for Question 2 is 1 mark)

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3 A moment of 45 N m is produced by a force acting at right angles to a lever, at a distance of 0.75 m from the pivot. Find the magnitude of the force.

(Total for Question 3 is 2 marks)

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4 A uniform beam AB has length 5 m and weight 240 N. The beam rests horizontally in equilibrium on two smooth supports, one at C, 0.8 m from A, and one at D, 1.2 m from B.

(a) By taking moments about C, show that the reaction at D, R_D, is 136 N. **(4)**

(b) Find the reaction at C, R_C. **(2)**

(c) State two assumptions made about the beam and its supports in this model, and explain briefly how each assumption is used in the calculation. **(4)**

(Total for Question 4 is 10 marks)

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5 A gardener uses a wheelbarrow to move garden waste. When lifting the wheelbarrow, it is modelled as pivoting about the axle of its single front wheel. The load of garden waste has weight 250 N and acts at a horizontal distance of 0.4 m from the wheel axle. The gardener applies a vertical lifting force at the handles, which are a horizontal distance of 1 m from the wheel axle. The wheelbarrow's own frame is light, so its weight may be ignored.

(a) Calculate the moment of the 250 N load about the wheel axle, stating the appropriate units. **(2)**

(b) Find the minimum vertical lifting force the gardener must apply at the handles for the wheelbarrow to begin to lift off the ground (other than at the wheel). **(2)**

(Total for Question 5 is 4 marks)

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6 A see-saw is modelled as a uniform rod PQ of length 4 m and weight 150 N, resting on a smooth pivot at its midpoint. Chandrika, of weight 320 N, sits at P. Tafari, of weight 400 N, sits on the see-saw between the pivot and Q so that the see-saw is horizontal and in equilibrium.

(a) Explain why the weight of the see-saw does not appear in the moments equation about the pivot. **(1)**

(b) Find the distance of Tafari from the pivot. **(4)**

(c) A third child, Nia, of weight 250 N, now also sits at Q itself, 2 m from the pivot, while Chandrika and Tafari stay in their original positions. Find the vertical force that must now be applied at P to restore equilibrium, stating whether it acts upward or downward. **(5)**

(Total for Question 6 is 10 marks)

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Mark scheme · 3.3 Mechanics: Moments: 30-minute Pack

Question 1

45 cao **B1**

Answer: 45 N m

Question 2

the sum of the clockwise moments about any point equals the sum of the anticlockwise moments about that point (oe) **B1**

Answer: The sum of the clockwise moments about any point equals the sum of the anticlockwise moments about that point.

Question 3

F = moment / d = 45/0.75 **M1**

60 N cao **A1**

Answer: 60 N

Question 4

(a) moments equation about C attempted, with all three terms present **M1**

(a) correct unsimplified equation: R_D x 3.0 = 240 x 1.7 oe **A1**

(a) rearranges to make R_D the subject **dM1**

(a) R_D = 136 N cso **A1**

(a) Answer: R_D = 136 N

(b) R_C = 240 - 136 (vertical equilibrium), ft their (a) **M1**

(b) R_C = 104 N cao **A1**

(b) Answer: R_C = 104 N

(c) states one valid assumption: the beam is uniform, the beam is rigid, or the supports are smooth (accept other valid modelling assumptions) **B1**

(c) explains how that assumption is used: uniformity places the weight at the midpoint; rigidity preserves the moment arms; smooth supports give no frictional forces (or a correct explanation of their valid assumption) **B1**

(c) states a second distinct valid assumption **B1**

(c) correctly explains how the second assumption is used in the calculation **B1**

(c) Answer: e.g. uniform (weight acts at midpoint); rigid (moment arms remain fixed because the beam does not bend)

Question 5

(a) moment = 250 x 0.4 oe **M1**

(a) 100 N m cao (units required) **A1**

(a) Answer: 100 N m

(b) takes moments about the wheel: F x 1 = 250 x 0.4 oe **M1**

(b) F = 100 N cao **A1**

(b) Answer: 100 N

Question 6

(a) the see-saw is uniform and the pivot is at its midpoint (centre of mass), so the weight acts through the pivot and has zero perpendicular distance, giving zero moment **B1**

(a) Answer: Weight acts through the pivot, so it has zero moment about it

(b) moments equation about the pivot: 320 x 2 = 400 x d oe **M1**

(b) 640 = 400d oe **A1**

(b) rearranges to make d the subject **dM1**

(b) d = 1.6 m cao **A1**

(b) Answer: 1.6 m from the pivot

(c) total moment on Tafari and Nia's side: 400 x 1.6 + 250 x 2 **M1**

(c) 1140 (N m) cao **A1**

(c) equation for extra force F at P: 320 x 2 + F x 2 = 1140 oe **M1**

(c) F = 250 N cao **A1**

(c) direction: downward (ft their F), since the Tafari/Nia side now has the greater moment and P's side must be increased to compensate **B1**

(c) Answer: 250 N, applied downward at P

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