3.7 Mechanics: Moments and Statics Depth: 30-minute Pack

Total Marks

EDEXCEL 9MA0 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A light rod AB rests horizontally in equilibrium on a pivot at C, under three weights of 15 N, 25 N and 42.5 N hanging from it (and the pivot reaction). Find the reaction at the pivot C.

(Total for Question 1 is 2 marks)

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2 A non-uniform rod AB of length 3 m is held horizontal by two vertical strings, one at A and one at B. The tension in the string at A is twice the tension in the string at B, and the weight of the rod is 90 N. Find the tension in the string at B.

(Total for Question 2 is 2 marks)

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3 A non-uniform rod is held horizontal by two vertical strings, with tensions T_A and T_B such that $T_A = 2T_B$ and $T_A + T_B = 90$ N. Find T_A.

(Total for Question 3 is 2 marks)

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4 A uniform rectangular lamina ABCD has AB = 4 cm and BC = 10 cm. Point masses of 2 kg are attached at each of the four corners, and the lamina itself has negligible mass. Taking A as the origin, with AB along the x-axis and AD along the y-axis, find the coordinates of the centre of mass of the system of four point masses.

(Total for Question 4 is 2 marks)

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5 A uniform beam AB has length 6 m and weight 210 N. The beam rests horizontally in equilibrium on two smooth supports, one at C, 1 m from A, and one at D, 4 m from A.

(a) By taking moments about C, show that the reaction at D, R_D, is 140 N. **(3)**

(b) Find the reaction at C, R_C. **(3)**

(Total for Question 5 is 6 marks)

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6 A shop sign of weight 80 N hangs in equilibrium from a single point on the sign. Two light inextensible strings are attached to this point, with their other ends fixed to a horizontal ceiling. String 1 makes an angle of 50 degrees with the ceiling, and string 2 makes an angle of 65 degrees with the ceiling, on opposite sides of the vertical through the sign. Model the sign as a particle.

(a) Find the tension in each string, giving your answers to 3 significant figures. **(7)**

(b) The sign is now instead supported by string 1 alone (still at 50 degrees to the ceiling) together with a smooth horizontal strut, fixed to a wall, which pushes horizontally on the sign. Find the tension in string 1 and the force in the strut. **(4)**

(Total for Question 6 is 11 marks)

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Mark scheme · 3.7 Mechanics: Moments and Statics Depth: 30-minute Pack

Question 1

resolve vertically: reaction = sum of the three weights (the rod is light) **M1**

82.5 N cao **A1**

Answer: 82.5 N

Question 2

resolve vertically: $T_A + T_B = 90$, with $T_A = 2T_B$, so $3T_B = 90$ **M1**

30 N cao **A1**

Answer: 30 N

Question 3

substitute $T_A = 2T_B$ into $T_A + T_B = 90$ to find $T_B = 30$, then $T_A = 2(30)$ **M1**

60 N cao **A1**

Answer: 60 N

Question 4

recognise that four equal masses at the corners of a rectangle have their centre of mass at the geometric centre **M1**

(2, 5) cao **A1**

Answer: (2, 5)

Question 5

(a) takes moments about C, using CD = 3 m and the beam's centre of mass 2 m from C **M1**

(a) $R_D * 3 = 210 * 2$ (correct equation) **A1**

(a) $R_D = 140$ (N) cso **A1**

(a) Answer: $R_D = 140$ N (shown)

(b) resolves vertically: $R_C + R_D = 210$ **M1**

(b) $R_C = 210 - 140$ **A1**

(b) $R_C = 70$ (N) cao **A1**

(b) Answer: 70 N

Question 6

(a) resolves horizontally: T1*cos(50) = T2*cos(65) **M1**

(a) correct equation **A1**

(a) resolves vertically: T1*sin(50) + T2*sin(65) = 80 **M1**

(a) correct equation **A1**

(a) eliminates one tension using the horizontal equation and solves the resulting equation in one unknown **M1**

(a) T2 = awrt 56.7 (N) **A1**

(a) T1 = awrt 37.3 (N) **A1**

(a) Answer: T1 = 37.3 N (string at 50 degrees); T2 = 56.7 N (string at 65 degrees), both 3sf

(b) resolves vertically: T1'*sin(50) = 80 **M1**

(b) T1' = 80/sin(50) = awrt 104 (N) **A1**

(b) resolves horizontally: strut force = T1'*cos(50) **M1**

(b) strut force = awrt 67.1 (N) **A1**

(b) Answer: T1' = 104 N; strut force = 67.1 N (both 3sf)

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