3.3 Mechanics: Moments: 1-hour Pack

EDEXCEL 9MA0 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A mechanic applies a force of 28 N at right angles to a car jack handle, at a point 1.5 m from the pivot. Find the moment of the force about the pivot.

(Total for Question 1 is 1 mark)

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2 A moment is the turning effect of a force about a point. State the two quantities whose product gives the magnitude of a moment.

(Total for Question 2 is 1 mark)

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3 A uniform beam AB of length 6 m and weight 180 N rests horizontally in equilibrium on two smooth supports, one at each end. Find the reaction at each support.

(Total for Question 3 is 2 marks)

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4 A non-uniform rod AB of length 2 m is held horizontal in equilibrium by two vertical strings, one attached at each end. The tension in the string at A is 30 N and the tension in the string at B is 50 N. Find the weight of the rod.

(Total for Question 4 is 2 marks)

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5 A uniform strut AB rests horizontally on two smooth supports, one at each end. The strut has weight 130 N. Given that the reaction at end A is 55 N, find the reaction at end B.

(Total for Question 5 is 2 marks)

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6 A force applied at right angles to a bicycle brake lever, at a distance of 0.08 m from the pivot, produces a moment of 3.6 N m. Find the magnitude of the force.

(Total for Question 6 is 2 marks)

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7 A cyclist applies a force of 400 N to a bicycle pedal, at an angle of 60 degrees to the crank arm, which has length 0.17 m. The bottom bracket of the bicycle acts as a fixed pivot for the crank.

(a) Calculate the perpendicular distance from the pivot to the line of action of the 400 N force, giving your answer to 3 significant figures. **(2)**

(b) Hence calculate the moment (turning effect) of the force about the pivot, stating the appropriate units, giving your answer to 3 significant figures. **(2)**

(c) The cyclist repeats the push, this time applying a force of the same magnitude perpendicular to the crank (that is, at 90 degrees to the crank). Find the percentage increase in the moment compared to part (b), giving your answer to 3 significant figures. **(2)**

(Total for Question 7 is 6 marks)

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8 A uniform rod AB has length 4 m and weight 100 N. The rod rests horizontally in equilibrium on two smooth supports, one at A and one at a point 2.5 m from A. By taking moments about A, find the reaction at the support 2.5 m from A.

(Total for Question 8 is 2 marks)

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9 A force of 80 N acts on a rod at an angle of 60 degrees to the rod, at a distance of 0.5 m from a pivot. Find the moment of the force about the pivot, giving your answer to 3 significant figures.

(Total for Question 9 is 2 marks)

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10 A force of 45 N acts on a bar at an angle of 40 degrees to the bar, at a distance of 0.8 m from a pivot. Find the moment of the force about the pivot, giving your answer to 3 significant figures.

(Total for Question 10 is 2 marks)

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11 A uniform rod is pivoted at its centre. A force of 60 N acts vertically downward at a distance of 0.9 m from the pivot on one side. Find the distance from the pivot at which a force of 45 N must act vertically downward on the other side, for the rod to remain in equilibrium.

(Total for Question 11 is 2 marks)

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12 The table below shows three forces acting at right angles to a light rod that is free to rotate about a fixed pivot O.

Force	Perpendicular distance from O	Sense
18 N	0.4 m	clockwise
25 N	0.5 m	anticlockwise
30 N	0.3 m	clockwise

Find the magnitude of the resultant moment about O, and state its sense.

(Total for Question 12 is 2 marks)

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13 A garden gate is opened by a force of 55 N applied at an angle of 70 degrees to the gate, at a point 0.9 m from the hinge. Find the moment of the force about the hinge, giving your answer to 3 significant figures.

(Total for Question 13 is 2 marks)

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14 A decorator uses a screwdriver as a lever to prise open a paint tin lid. She applies a force of 40 N to the screwdriver at an angle of 25 degrees to the screwdriver, at a distance of 0.14 m from the pivot (the rim of the tin). Find the moment of the force about the pivot, giving your answer to 3 significant figures.

(Total for Question 14 is 2 marks)

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15 A non-uniform rod AB has length 3.6 m. The rod is held in equilibrium in a horizontal position by two vertical strings, one attached at A and the other attached at a point 2.4 m from A. The tension in the string at A is 45 N and the tension in the other string is 75 N.

(a) Find the weight of the rod. **(2)**

(b) By taking moments about A, find the distance from A to the centre of mass of the rod. **(4)**

(c) State, without further calculation, whether the centre of mass lies closer to A or to the point where the 75 N string is attached. Justify your answer. **(2)**

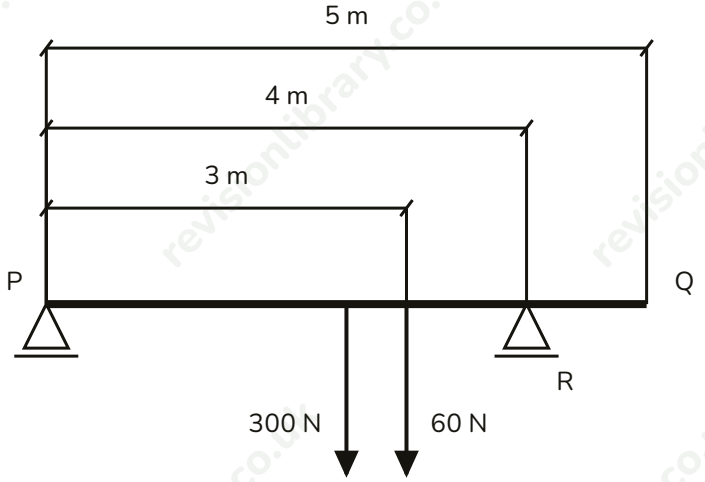
(Total for Question 15 is 8 marks)

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16 A uniform plank footbridge PQ over a garden pond has length 5 m and weight 300 N. It rests horizontally on two supports, one at P and one at R, where PR = 4 m (so R is 1 m from Q). A garden ornament of weight 60 N sits on the plank at a point 3 m from P. A student's attempt to find the reaction at R by taking moments about P is shown below:

Moments about P: R x 4 = 300 x 2.5 + 60 x 4
R = (750 + 240) / 4
R = 247.5 N

Diagram NOT accurately drawn



(a) Identify the error in the student's working, and state the correct distance that should have been used. **(2)**

(b) Hence find the correct value of R. **(3)**

(c) Find the reaction at P. **(2)**

(Total for Question 16 is 7 marks)

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17 A non-uniform rod AB has length 3 m and rests horizontally on a support at A. The rod is held horizontal by a light vertical string attached at B. The weight of the rod is 84 N and acts at a point 2 m from A. Show that the tension in the string at B is 56 N, and find the reaction at the support at A.

(Total for Question 17 is 3 marks)

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Mark scheme · 3.3 Mechanics: Moments: 1-hour Pack

Question 1

42 cao **B1**

Answer: 42 N m

Question 2

the magnitude of the force and the perpendicular distance from the point to the line of action of the force **B1**

Answer: The magnitude of the force and the perpendicular distance from the pivot to the force's line of action.

Question 3

by symmetry, or by taking moments, each reaction supports half the weight **M1**

90 N at each support **A1**

Answer: 90 N at each support

Question 4

resolve vertically: weight = sum of the two tensions **M1**

80 N cao **A1**

Answer: 80 N

Question 5

resolve vertically: $R_A + R_B$ = weight, so R_B = 130 - 55 **M1**

75 N cao **A1**

Answer: 75 N

Question 6

F = moment / d = 3.6 / 0.08 **M1**

45 N cao **A1**

Answer: 45 N

Question 7

(a) d = 0.17 x sin(60 degrees) oe **M1**

(a) awrt 0.147 (m) **A1**

(a) Answer: 0.147 m (3 s.f.)

(b) moment = 400 x their (a), or 400 x 0.17 x sin(60 degrees) **M1**

(b) awrt 58.9 N m (units required), ft their (a) **A1**

(b) Answer: 58.9 N m (3 s.f.)

(c) new moment = 400 x 0.17 (= 68 N m) **M1**

(c) awrt 15.5% increase, ft their (b) **A1**

(c) Answer: 15.5% increase (3 s.f.)

Question 8

take moments about A: R x 2.5 = 100 x 2 (weight acts at the midpoint, 2 m from A) **M1**

80 N cao **A1**

Answer: 80 N

Question 9

moment = 80 x 0.5 x sin60 **M1**

awrt 34.6 N m **A1**

Answer: 34.6 N m (3 s.f.)

Question 10

moment = 45 x 0.8 x sin40 **M1**

awrt 23.1 N m **A1**

Answer: 23.1 N m (3 s.f.)

Question 11

take moments about the pivot: 60 x 0.9 = 45 x d **M1**

1.2 m cao **A1**

Answer: 1.2 m

Question 12

total clockwise moment = (18 x 0.4) + (30 x 0.3) = 16.2; total anticlockwise moment = 25 x 0.5 = 12.5 **M1**

3.7 N m clockwise cao **A1**

Answer: 3.7 N m, clockwise

Question 13

moment = 55 x 0.9 x sin70 **M1**

awrt 46.5 N m **A1**

Answer: 46.5 N m (3 s.f.)

Question 14

moment = 40 x 0.14 x sin25 **M1**

awrt 2.37 N m **A1**

Answer: 2.37 N m (3 s.f.)

Question 15

(a) W = 45 + 75 (vertical equilibrium) **M1**

(a) W = 120 N cao **A1**

(a) Answer: 120 N

(b) moments equation about A attempted, with correct terms **M1**

(b) correct unsimplified equation: 75 x 2.4 = 120 x d oe **A1**

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

(b) d = 1.5 m cao **A1**

(b) Answer: 1.5 m from A

(c) correct statement: closer to the point where the 75 N string is attached **B1**

(c) valid reason: the larger tension supports more of the weight, so the centre of mass lies nearer to that string, oe **B1**

(c) Answer: Closer to the 75 N string

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Question 16

(a) identifies that the student used 4 m (the distance PR) as the lever arm for the ornament's weight, instead of the ornament's own distance from P **B1**

(a) states the correct distance is 3 m (the ornament's actual position from P), so the correct moment term is 60 x 3, not 60 x 4 **B1**

(a) Answer: The ornament's distance from P should be 3 m, not 4 m

(b) correct moments equation: R x 4 = 300 x 2.5 + 60 x 3 **M1**

(b) R x 4 = 930 oe **A1**

(b) R = 232.5 N cao **A1**

(b) Answer: R = 232.5 N

(c) R_P = 300 + 60 - 232.5 (vertical equilibrium), ft their (b) **M1**

(c) R_P = 127.5 N cao **A1**

(c) Answer: 127.5 N

Question 17

take moments about A: T x 3 = 84 x 2 **M1**

cso: T = 168/3 = 56 N, as required **A1**

resolve vertically: R_A = 84 - 56 = 28 N cao **B1**

Answer: T = 56 N (shown); reaction at A = 28 N.

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