Test answers - Moments

Year: Year 13 · Duration: 40 minutes · /20

Answer to Question 1 (4 marks)

Method: the moment of a force about a point is force $\times$ perpendicular distance from the point to the line of action. For a body in equilibrium, the resultant force is zero and the total clockwise moment equals the total anticlockwise moment about any point. Mark scheme as shown in brackets.

a. For the 40 N force, only the component perpendicular to the rod, $40\sin 35^\circ$, has a turning effect. Anticlockwise: $25 \times 0.6 = 15$ N m (1). Clockwise: $40\sin 35^\circ \times 0.5 = 11.47$ N m (1).
b. Subtract the smaller moment from the larger one; the larger one decides the direction. Net $= 15 - 11.47 = 3.53$ N m (1), anticlockwise (1). So the rod turns anticlockwise with a net moment of about 3.53 N m.

Answer to Question 2 (4 marks)

Method: draw a force diagram (the weight of a uniform body acts at its midpoint). Take moments about a point where an unknown force acts, so that this force disappears from the equation, then resolve vertically to find the remaining force. Mark scheme as shown in brackets.

Moments about D: $R_C \times 4 = 30g \times 2 + 20g \times 4.5 = 150g$ (2), so $R_C = 37.5g = 367.5$ N (1). $R_D = 50g - 367.5 = 122.5$ N (1).

Check with moments about C: $R_D \times 4 = 30g \times 2 - 20g \times 0.5 = 50g$, so $R_D = 12.5g = 122.5$ N. Answer: $R_C = 367.5$ N and $R_D = 122.5$ N.

Answer to Question 3 (4 marks)

Moments about C: the girl is 0.5 m from C on one side and the plank centre is 1.5 m from C on the other. $R_D \times 3 = 16g \times 1.5 - 40g \times 0.5 = 4g$ (2). $R_D = \dfrac{4g}{3} = 13.1$ N (1). It is positive, so D is still in contact and the plank does not tilt (1).

Total weight $56g$, so $R_C = 56g - \frac{4}{3}g = \frac{164}{3}g \approx 536$ N. The plank would only tilt about C if the girl moved far enough out for R_D to reach zero.

Answer to Question 4 (4 marks)

Method: draw a force diagram (the weight of a uniform body acts at its midpoint). Take moments about a point where an unknown force acts, so that this force disappears from the equation, then resolve vertically to find the remaining force. Mark scheme as shown in brackets.

a. Only the vertical component $T\sin 30^\circ$ has a moment about A; the weight acts 0.8 m from A. Moments about A: $T\sin 30^\circ \times 1.6 = 5g \times 0.8$ (2), so $T = \dfrac{39.2}{0.8} = 49$ N (1). So the tension is 49 N.
b. Resolve vertically: the hinge and the string together support the weight. $Y = 5g - T\sin 30^\circ = 49 - 24.5 = 24.5$ N upwards (1). So the hinge pushes up with 24.5 N.

Answer to Question 5 (4 marks)

Method: draw a force diagram (the weight of a uniform body acts at its midpoint). Take moments about a point where an unknown force acts, so that this force disappears from the equation, then resolve vertically to find the remaining force. Mark scheme as shown in brackets.

a. The 4 kg mass is 1.1 m from the pivot on one side, so the centre of mass of the rod is on the other side, at $(d - 1.1)$ m. Moments about the pivot: $4g \times 1.1 = 6g(d - 1.1)$ (1), so $d - 1.1 = 0.7333$ (1) and $d = 1.83$ m (1). So the centre of mass is about 1.83 m from A.
b. Resolve vertically: the pivot supports both weights. $R = 10g = 98$ N (1). So the pivot pushes up with 98 N.